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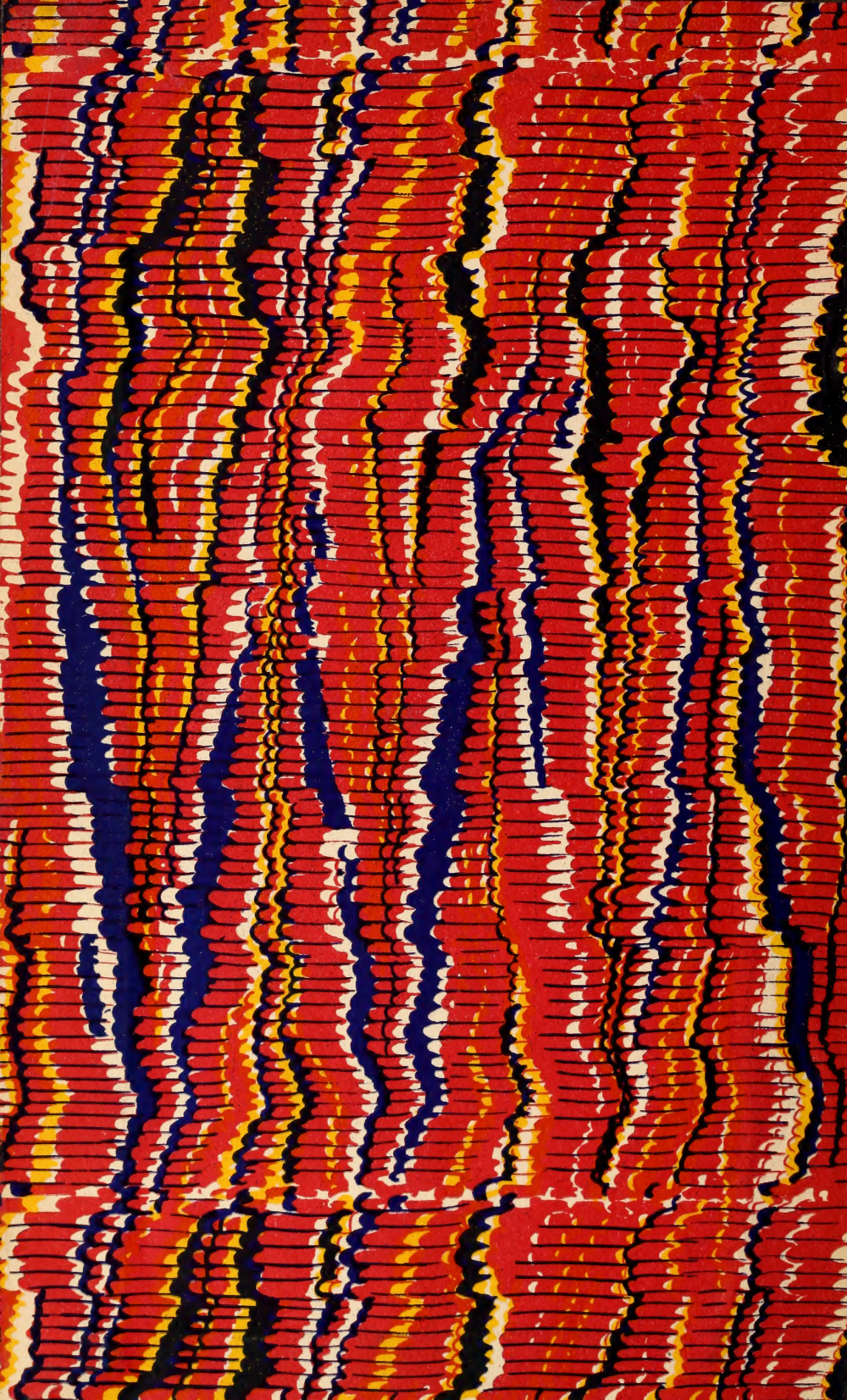

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REPORT OF THE SECRETARY OF AGRICULTURE - 1927

REPORT

OF THE

SECRETARY OF AGRICULTURE

1927

UNITED STATES
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REPORT OF THE SECRETARY OF AGRICULTURE

WASHINGTON, D. C., *November 3, 1927.*

To the PRESIDENT:

THE YEAR IN AGRICULTURE

Agriculture in the United States during the last year has made substantial progress in recovery from the effects of the postwar depression. Progress is manifest in better balanced production, in advancing prices for some important crops, notably cotton and cattle, and in further improvement in the relationship between the prices of farm products and the prices of other goods. This relationship is expressed by the Department of Agriculture in index numbers showing the purchasing power of a unit of farm products in terms of nonagricultural goods. On September 15 the index number indicating this purchasing power was 92, compared with an average of 85 for the year 1926, with 100 representing the average for the five years preceding the war. Since June, 1921, when the depression was at its worst, the unit buying power of farm products has increased more than 35 per cent. This means that agriculture has regained more than three-fourths of the buying power lost per unit of its products in the postwar price decline.

It is important to bear in mind, moreover, that the improvement thus registered in the purchasing power index does not show the full extent of the recovery effected. Index numbers indicating gains in the exchange value of farm commodities tell only part of the story. They do not accurately reflect advantages accruing from increased efficiency. In the last few years the productivity of American agriculture, as measured in output per farm worker, has increased greatly. On fewer acres, and with a farm population 3,000,000 less than in 1919, the agricultural industry since 1923 has averaged a larger volume of production than in the years immediately following the war. This suggests the practical certainty that relative costs of production have been reduced despite continuing high overhead and labor expense, a view that is strengthened by data recently made available showing a tremendous recent increase in the use of large power units in agriculture. Another indication that the purchasing power index does not record all the progress achieved is the fact that since 1921 net farm incomes, with some recession in 1926–27, have increased more rapidly than the unit purchasing power of farm products. It is a reasonable inference that the farmers, through increased efficiency, are offsetting, to some degree at any rate, the effect of unfavorable relative prices.

Increased Net Income Probable

In the crop year 1926–27 the net income of agriculture, owing mainly to declines in cotton prices in the early part of the season, fell somewhat below the level reached in 1925–26. This year some improvement is expected. Moreover, areas where distress has been acute in recent years are this year marketing good crops at good prices. Montana and parts of the Dakotas are conspicuous examples. Crop yields in Montana were nearly 50 per cent above the average for the last 10 years. In the Dakotas, Nebraska, Idaho, and Oregon yields were from 10 to 20 per cent better than usual. In the Cotton Belt generally, notwithstanding poor yields in certain areas in eastern Oklahoma and New Mexico and heavy losses from flood damage in the Mississippi Valley, farm returns are expected to be up to the average of recent years. The troubles of the farmer are not yet over, but the balance of the year's developments is on the side of progress.

Although unfavorable weather delayed planting, and the season started under discouraging conditions, production of the principal crops was estimated in October to be 1 per cent above the average during the last five years and only 1 per cent below that of 1926. This result was obtained on a crop acreage about 1 per cent less than that of last year. Such an achievement is surprising in view of the difficulties encountered. Growers of cotton and tobacco faced low prices at planting time. In Florida and in a large area extending through southwestern Kansas, western Texas, and eastern New Mexico long-continued drought damaged growing crops. Floods covered 4,500,000 acres of crop land in the Mississippi Valley. Up to June 5 only a fourth of the intended corn acreage had been planted in the lower Ohio Valley, and only a half in a large part of the eastern and central Corn Belt. Yet the total crop production, besides being above the average of recent years, is so well balanced that no marked scarcity exists of any product. Previous heavy stocks of cotton, tobacco, and canned goods will be reduced, but this is a favorable change. As far as weather conditions permitted, farmers planted the best-planned acreage in many years. Few signs of excessive production are evident with the exception of hay.

Striking Change in Cotton

The most striking change in the agricultural situation this year, as compared with that of 1926, is in the Cotton Belt. The year's cotton crop was estimated in October at 12,672,000 bales, compared with 17,977,000 bales produced in 1926. From the standpoint of price the improvement has been remarkable, and it is estimated that should cotton prices continue at their present level, returns to farmers for lint alone will exceed by about $150,000,000 the income from last year's crop. Acreage reduction, boll-weevil damage, and the Mississippi floods mainly account for the fact that this year's cotton crop is nearly one-third smaller than that of last year. Cotton area this year as estimated in September was 40,626,000 acres, compared with 47,087,000 acres picked last year. Although floods in the Mississippi Valley accounted for some of the reduction in cotton planting, the farmers themselves, acting on the advice of Federal and State Departments of Agriculture, agricultural colleges,

and cooperative marketing agencies, effected much of the reduction voluntarily, thereby showing that intelligent action to readjust production to demand in agriculture is practicable on a large scale.

In the Corn Belt production of corn is 10 per cent greater than last year, although 1 per cent below the average production of the last five years. For the country as a whole, the corn crop is estimated at 2,753,000,000 bushels, compared with 2,647,000,000 bushels harvested last year and a five-year average of 2,767,000,000 bushels. This production was the greatest surprise of the season. A late start and slow growth made it seem almost inevitable that much of the corn crop would be caught by frost. In the eastern and central Corn Belt, from western Pennsylvania to western Iowa and Minnesota and south through Kentucky, yields were unfavorable. West of this region, however, conditions were good. Nebraska's corn crop was nearly twice as large as that of last year, and that of Kansas three times as large.

Corn-Belt Situation

Corn prices advanced during the summer to nearly $1 a bushel at local farm markets, compared with about 65 cents in the summer of 1926. On September 15 the average farm price of corn was 95 cents, compared with 76 cents in September, 1926. This advance in corn prices, however, is partly offset, from the standpoint of Corn-Belt incomes, by lower hog prices. It is, therefore, doubtful whether the Corn Belt will effect as much improvement in its financial situation this year as some other sections. Decreased foreign demand has been a factor in the decline of hog prices, although increased marketings have played a part also. However, cattle feeding, an important source of income to the Corn Belt, should give increased returns.

The Wheat Belt, especially the northern part of the winter wheat and all of the spring wheat area, has had a good year. Spring wheat was a large crop, and wheat prices have held up fairly well. Taking spring and winter wheat together, the country harvested its largest wheat crop since 1922. A prospective increase in the world wheat supply is causing the crop to be marketed at prices slightly lower than those prevailing last year. Desirable milling wheat for domestic consumption, however, has given returns to the grower of at least 15 cents a bushel above the value of the export grades. At Kansas City choice dark hard winter wheat has been commanding premiums as high as 35 cents a bushel. On one car at Minneapolis a premium of 65 cents a bushel over the December future was paid. This car showed 16 per cent protein. Our export wheat consists generally of the nonpremium grades.

Moreover, production costs have been reduced through technical progress, particularly in the spread of combine harvesters. Accordingly, wheat growers with arrears of indebtedness left by the postwar depression have been able to diminish their obligations.

Wheat production is estimated at 867,000,000 bushels, compared with 833,000,000 bushels harvested last year and a five-year average of 808,000,000 bushels. Winter wheat comprised 553,000,000 bushels of the total. Durum production was 80,000,000 bushels, and spring wheat other than durum 234,000,000 bushels. All spring wheats gave remarkably good yields.

Oats Crop Below Average

Oats had a poor start, and the total crop is estimated at 1,206,000,000 bushels, or about 4 per cent less than the quantity harvested last year and 10 per cent below the average production of the last five years. Barley, planted on a largely increased acreage, yielded 265,000,000 bushels compared with 188,000,000 bushels last year. Increased acreage planted to buckwheat and a yield close to the average make the out-turn of that crop nearly 15,800,000 bushels, the largest since 1918. Unusual yields of flax on a slightly reduced acreage gave a production of about 24,300,000 bushels, the second largest production of flax in 15 years. Rice production, estimated at 37,900,000 bushels, is close to recent average output.

Conditions have greatly improved in tobacco-growing sections where depression was marked last year. This year's production will be marketed under relatively favorable conditions, accumulated surpluses of old leaf having been largely cleared away. However, in the Southeastern States, where production was stimulated by favorable prices in 1926, conditions this year may be not quite so favorable as they were last year.

Tame hay, a crop largely fed to livestock on the farms where it is grown, was the largest crop on record. It is estimated at 103,800,000 tons, compared with 97,622,000 tons produced in 1924, the previous high-record year. On an increased acreage abundant rainfall gave large yields in practically all important hay-producing States. Yield of wild hay per acre seems likewise to have been unusually large.

Cattle and Sheep Industries

Good conditions prevail in the cattle and sheep industries. The average price of slaughter steers at Chicago in September, 1927, was $2.63 per 100 pounds higher than a year ago. This is an advance of about 25 per cent. Some of the better grade steers averaged as much as 35 per cent higher than a year ago. Stocker and feeder cattle showed a 19 per cent advance for the year. Top slaughter steers in Chicago about the middle of October sold up to $17.25 per 100 pounds, compared with a top of $12.70 in October, 1926. Cattlemen are optimistic and are restocking their ranges. Accordingly, marketing of cattle has been less than last year. This year's incomes from cattle sales will therefore not record the full improvement made in the situation, notwithstanding the fact that such incomes will be unusually satisfactory. The cattle industry is accumulating resources which should be reflected in satisfactory incomes for several years. Statistically, the beef industry is in an exceptionally strong position. Provided production is not overdone and emphasis is placed on good-quality cattle, it should hold its advantage for a considerable period. Market supplies in the fall were materially smaller than for some years, and prices for approximately all classes and grades of cattle were remunerative to both ranchmen and feeders, especially to the more efficient ones.

Although the market price of lambs has averaged somewhat lower this year than it did in 1926, the sheep industry as a whole remains in good shape. Sheepmen generally have prospered. In a market

so narrow as that for lamb and mutton, there is always danger of overproduction, and the tendency toward expansion which has been manifested by the sheep industry for several years past suggests that this danger should be kept in mind. Nevertheless, markets have not been glutted and prices have remained profitable. Moreover, consumption of mutton and lamb probably can be increased. Wool prices have remained on a steady and firm level and have been fairly profitable to growers. Imports of combing and clothing wool were approximately 100,000,000 pounds less than in the preceding year, and sales at primary markets developed decided strength.

The Swine Industry

From the standpoint of prices, the swine industry encountered relatively unfavorable conditions this year, although neither production nor market supplies were excessive. From February to the end of the summer hog prices declined approximately $3.50 per 100 pounds. This decline resulted primarily from a sharp curtailment in the foreign demand for American pork and pork products. In some countries the reduction amounted to 50 per cent compared with takings in 1926. Fortunately much of the American pork marketed in the earlier part of the year was produced on relatively cheap corn. In the late summer, the corn-hog price ratio became unfavorable for the hog producer and suggested the necessity for readjustments in production. In September and October, however, corn prices declined and hog prices advanced. At this writing the corn-hog price ratio is not unfavorable for hog feeding.

The Dairy Industry

The dairy industry has enjoyed another good year. Although the general trend of dairy production continues upward, consumption of all dairy products has more than regained the momentum acquired before the war and the outlook is favorable. Estimates of total market production in the United States during recent years show that there has been an average annual increase of about 4,000,000,000 pounds of milk. This increase has been absorbed for the most part by increased consumption of fluid milk and butter. Some important shifts are taking place in the manufacture of dairy products. Cheese production is declining, owing, in part, to an increased demand for milk for other uses. On the other hand the production of condensed and evaporated milk is increasing. The future prosperity of the American dairy industry depends largely on the domestic consumption. If, as is probable, this continues to increase, the outlook is encouraging, because existing tariff duties give reasonably effective protection from foreign competition.

Poultry Outlook Improved

In the poultry industry conditions have been somewhat less satisfactory during the last year than in 1926. Egg production was heavy until June 1, 1927, and low prices failed to stimulate consumption sufficiently to absorb the increased output. Marketings of poultry likewise were heavy enough to offset severe price concessions. During 1927 all classes of poultry sold at prices below those of the previous year. At the same time poultry feeds advanced in price.

Toward the middle of the year, however, a tendency toward improvement appeared, and by fall a recovery was well under way. Declining market receipts of eggs, an accelerated movement of eggs out of storage, and the reduction in stocks of frozen poultry to normal levels have put a new face on the situation. The poultry industry is now in better shape than at any previous time this year. Apparently production has been sufficiently curtailed to enable the industry to go ahead on a sound and profitable basis.

Fruits and Vegetables

Most staple lines of fruits and vegetables, with the exception of potatoes and sweet potatoes, are bringing prices equal to or considerably higher than those of last year. Tree crops have been lighter than in any recent season. Commercial apple production was estimated in October at about 24,300,000 barrels, compared with 39,400,000 barrels last year, when the output was the heaviest on record. The crop is about evenly divided between the Western States and the eastern and central apple regions, the big drop in production occurring in the latter area. Prices in the principal markets on October 1 were from 50 to 75 cents a bushel higher than for the previous year, although the quality of the supply was lower. Peach production dropped about one-third from the heavy crop of 1926, and peach prices ruled generally higher. Pear production likewise declined materially. These lower production results were accompanied by price gains promising increased total returns.

Strawberries, with a production of 329,336,600 quarts, showed a large increase over the 274,429,000 quart crop of 1926. Estimated production of grapes is 2,550,000 tons, an increase of 450,000 tons over the five-year average prior to 1926. A record crop of 18,000,000 bushels of late onions is expected, or 4,500,000 bushels above the five-year average. Cabbage production is also higher. Despite the increased production, prices of both cabbages and onions are about the same as a year ago.

Potato production on October 1 was estimated at 395,000,000 bushels, or 39,000,000 bushels more than in 1926 and 1,000,000 bushels more than the average for the five years preceding 1926. Potato prices have been from a fourth to a third lower than those of a year ago. Sweet potato production is expected to total 87,500,000 bushels, or 3,800,000 more than in 1926.

Foreign Markets

Record export shipments of cotton and fruit and substantial increases in exports of wheat, rice, and rye, with a marked decline in pork-product shipments, feature in the foreign-trade record for 1926–27. Quantities were higher than in any year since 1921–22, but low prices caused comparatively low returns. Agricultural products constituted 42 per cent of export values as compared with 48 per cent in 1924–25.

Low prices, appealing to European buyers, and economic recovery in Europe explain the record shipment of 11,281,000 bales of cotton. Economic recovery, coupled with low production in Europe, de-

manded exports of wheat and flour 103 per cent greater than in the previous year and 90 per cent more valuable. California rice, produced in abundance, was exported in considerable quantities to Japan. Southern rice growers sold in Europe and Latin America.

The coal strike in Great Britain and civil disturbances in China limited the demand for bright flue-cured tobacco, and exports declined 11 per cent. Germany and the Netherlands, however, took larger quantities. These two countries and Spain and Belgium also bought more of the heavier tobaccos, which more than offset light purchases by the United Kingdom and France.

Heavy fruit crops in the United States and light ones in Europe in 1926 favored heavy exports of apples and other fruits. Germany's takings of apples increased 250 per cent. Exports of oranges and grapefruit increased, and the presence of so many fresh fruits on the European markets made prune prices so low that the 15 per cent larger export was 5 per cent less valuable. Demand for pork products declined. European production recovered somewhat, and the British quarantine on continental cured pork kept continental products at home.

For the immediate future the textile situation is not favorable in Great Britain, France, and Italy. Germany, central Europe, and most of the other European buyers, with the exception of Denmark and Norway, are more favorably situated and current demand should continue. Chinese disorder, reflected also in Japanese textile depression, does not promise a good market in the Orient.

A tendency continues for imports of dairy products to exceed exports increasingly. Exports of condensed and evaporated milk declined 20 per cent. Butter prices abroad were consistently lower than in the United States, and at times this margin exceeded the 12 per cent tariff and resulted in imports. In recent months the foreign prices have increased and this has reduced the pressure on the domestic market.

Farm Position Still a Problem

In general the showing for the year is good. Yet much remains to be done before the position of the farmer will cease to constitute a problem. In order to achieve higher net incomes for agriculture, advance is necessary along several lines. While farmers themselves are reducing their costs of production through increased efficiency, public agencies should cooperate with them in effecting a better adjustment of production to demand. Also efforts should be made to diminish waste, to lessen margins between producers' and consumers' prices, to reduce transportation and distribution costs, and to lessen the farmer's overhead charges by lowering or redistributing tax burdens and by improving agricultural credit facilities. Farmers should be encouraged to enhance their bargaining power through cooperative marketing, and the responsibility of the public in helping to reduce price fluctuations due to unavoidable gluts and shortages of agricultural products should be recognized in a practical manner. Overemphasis on the fairly satisfactory results of a single year may cause us to forget the existence of underlying causes of farm difficulty, and therefore to neglect practicable means of affording relief.

TECHNICAL PROGRESS SINCE THE WAR

Thus far I have discussed the current situation. It is impossible, however, to gauge the condition of agriculture on the basis merely of this year's yields and prices of farm commodities. Such data may tell us where the agricultural industry stands, but not the direction in which it is headed—and in agriculture long views are imperative.

The best way to visualize the future of agriculture, as of any industry, is to examine and apply the examples of its recent past. If the farmer has tackled his problems sensibly and energetically, with resulting increase of efficiency in both production and marketing, his outlook may fairly be considered good. This he has done in a manner which has no historical parallel. Technical progress in American agriculture has taken place at an extraordinary rate since the close of the World War, and in consequence the productivity of the individual farmer has been increased, while at the same time the agricultural industry as a whole, through the shifting of crop enterprises, has been better adapted to its market conditions.

In the nine years since the World War ended, our agriculture has undergone far-reaching changes that have materially increased the output of both land and labor. Tractors have replaced many horses and mules, releasing land for other uses than the production of feed and forage. Improved harvesting machinery has come into wide use. The size of the average farm has increased. More productive crops have been planted. Livestock of increased productivity has become widely dispersed. Farm management has become more efficient, a better balance has been established among agricultural enterprises, and progress has been made in adjusting production to market requirements. The result is an increase in farm production more rapid than the rise in the country's population.

This augmented production has been obtained on a decreased crop acreage and with fewer farm workers. Here is evidence that agriculture has not lacked vigor or resourcefulness in the trying years of the postwar depression. Here also is an augury of its future prosperity. Although the increased production of the postwar period undoubtedly has tended to depress farm-commodity prices, it has probably been associated with a decrease in production costs; and it is not the price of a commodity, but the margin between that price and its cost of production, that determines the farmer's profit. Farm efficiency has been increasing, and efficiency in production coupled with a better adjustment of production to market requirements is a corner stone of agricultural prosperity.

Decrease in Crop Land

From 1919 to 1924 there was a decrease of 13,000,000 acres in crop land in the United States—the first decrease ever shown by census statistics in the agricultural area of the Nation. There occurred at the same time a decrease in the number of farm animals, a decrease in the number of farms, and a decrease of farm population. Under such circumstances one would hardly expect an increase in the volume of farm production. Yet an increase took place, and a very substantial one. It is estimated that crop production in the period 1922–1926 was nearly 5 per cent greater than in

the period 1917–1921, although the aggregate acreage in crops decreased slightly. Likewise, the output of animal products is estimated to have increased fully 15 per cent. The increased productivity of the farm worker is estimated at about 15 per cent. This increase in labor efficiency, probably never before equaled, is attributable in part to the utilization of more productive livestock and crops, in part to the increased use of machinery and power on the farm.

Better Utilization of Feed

Important gains have been made in the amount of milk and meat produced per unit of feed consumed. About two-thirds of the estimated increase in farm production for the five years 1922–1926 over that for the five years 1917–1921 is attributable to an increase in the output of animal products. In the later period about 20 per cent more milk was produced from only 4 per cent more dairy cows and heifers, and the output of meat and other animal products in relation to feed consumption increased about 9 per cent. Fully one-third of this increase, however, is due to a shift from beef cattle toward dairy cattle and hogs. These animals produce more human food per unit of feed consumed than do beef cattle.

Changes in crop production contributed to the increase in total farm output. In general, the crop shifts made were toward crops with a higher acre value. In the Cotton Belt there was a notable shift from corn to cotton. In the western Corn Belt and in the spring-wheat region a marked shift from wheat to corn took place. California and Florida largely increased their acreages of fruits and vegetables. About two-thirds of the increase in crop production per acre between 1922–1926 and 1917–1921 is associated with this shift from less productive to more productive crops per acre, while the remaining third is attributed to higher yields per acre.

Various agencies have assisted farmers in effecting this progress, among them the agricultural press, farm organizations, agricultural colleges, experiment stations, extension services, and the Federal and State departments of agriculture. My present purpose, however, is not to list the parts played by these different agencies in increasing the efficiency of agriculture, but merely to note certain indications that the American farmer is dealing effectively with the problem of putting his business on a paying basis.

Accelerated mechanization since the World War has released for other uses from 15,000,000 to 20,000,000 acres of crop land formerly required to feed horses and mules. Only an imperfect indication of the scale on which power has come into use in agriculture recently is given, however, by statistics showing decreases in the number of mature horses and mules on farms. Thus, on January 1, 1920, the number of these animals on farms was 21,873,000. By January 1, 1925, it had dropped to 20,619,000, while at the same time the number of tractors on farms had increased from 246,000 to 506,000. A large increase has taken place also in the use of stationary gas engines and electricity on farms. Motor trucks and automobiles, of course, have increased greatly the power available for transporting farm products to market. In this five-year period the increase in mechanical horsepower on farms was probably five times as great as the decrease in animal horsepower.

Tractors on Farms

In regions where industry has been expanding rapidly and paying wages higher than farmers can afford, the increase in the number of tractors in agriculture has been extraordinary. The increase has been greater in Pennsylvania, New York, the Lake States, the eastern Corn Belt, and California, where the farms are of medium size, than in the Central States and far West, where the farms are larger. This should not be taken to imply, however, that the increase in the use of power machinery has been small in the latter regions. In these regions a great increase in the use of large power units has taken place.

Power machinery, besides increasing the productivity of the individual farm worker, influences the size of farms, the distribution of crops, and the choice of farm enterprises. Census data indicate a decrease in the number, accompanied by an increase in size, of farms in some States where the number of tractors has greatly expanded. In western Texas and Oklahoma, where large power units are in general use, the amount of crop land cultivated per man is much greater than in the "old South."

Effects of the wider use of power machinery are also to be seen in the movement of corn production westward and northward since the war. Census returns show a large increase in corn acreage northwest of a line drawn from central Oklahoma diagonally across Missouri and Illinois to Lake Michigan. In the States south and east of this line there has been an almost equal decrease. Lower costs of production, made possible by power machinery, tend steadily to push the arid margin of crop production farther west, a movement that is forwarded by the development of short-season and of drought-resistant varieties of corn.

These influences are still more striking in the case of wheat. Census figures show that between 1919 and 1924 wheat acreage was extended considerably into the semiarid region in the Great Plains. Moreover, in all the States in this region, except New Mexico, the acreage of wheat since 1924 has continued to increase, while at the same time the number of farms has diminished. This is evidently due in part to the influence of power machinery.

Another consequence of the spread of power machinery in agriculture is the expansion of agriculture into regions where conditions largely necessitate specialized, as distinguished from diversified, agriculture. Such regions exist in the Great Plains, where wheat growing has undergone considerable expansion in recent years, and in Texas and Oklahoma, where there is a tendency toward specialization in cotton growing. It is largely machinery that enables farmers to enter such regions and raise crops profitably.

This tendency toward specialization in certain areas has undoubtedly influenced farming practices elsewhere. The competition of areas exceptionally well adapted to power farming tends to eliminate the growing of small grains on some farms in the older farming sections. In the Great Plains, farms growing small grains have increased in number in recent years, while in the country as a whole the number of farms growing wheat and corn for grain has decreased. It is not improbable that there is indicated here the beginning of a process of geographic specialization in the production of

crops adapted to mechanized farming. Probably the types of agriculture suited to power cultivation will be more and more concentrated in relatively level areas where large farms are practicable, while the older farming regions may tend to concentrate increasingly on diversified farming.

Diversification Possibilities Limited in Some Areas

A system of farming which includes a number of different crops and one or more livestock industries naturally runs less risk of complete seasonal failure than a system based on a single crop or a single livestock industry. Diversification of crops reduces climatic and economic hazards, promotes crop rotation, facilitates the control of plant insects and plant diseases, and permits an efficient employment of labor, power, and machinery throughout the year. In certain regions, however, such as on the dry lands of the West, the possibilities of diversification are limited. Much of the arable land there has accordingly been used extensively for wheat growing. Ranch resources are utilized by cattle or sheep. Special crop or livestock industries of this sort are subject to great climatic hazards. Yet in the semiarid region it has not been found practicable to accomplish much through diversification of crops. Progress in the efficient utilization of semiarid lands has been made, however, through cheaper methods of production and improved credit facilities.

In manufacturing industries great progress in reducing production costs has been made by mass production. This method, which is essentially one of job specialization, has its counterpart in certain branches of agriculture, particularly cotton and wheat growing. It has been possible by specialization greatly to reduce the cost of producing these crops. By the use of larger operating units, more efficient power and machinery, and skilled labor, crop specialization has often effected important economies. The system, however, suffers the disadvantage of seasonal hazards which may be so severe as to result in partial or complete crop failures.

These hazards must clearly be offset by the profits of favorable seasons if the enterprises in question are to continue. In certain regions this is normally the case. Sometimes, however, farmers are not able to take advantage of this circumstance because they are without suitable credit facilities. Capital or credit to carry his operations through only one season is not sufficient for the specialized crop farmer. What he needs is a credit system adapted to the peculiar conditions of his business. In other words, his credit facilities must enable him to take advantage of the fact that in the long run seasonal crop failures are likely to be more than offset by the profits of favorable seasons. Something has already been done to meet this necessity, but it ought to be possible to make better provision for it.

It is well to bear in mind, when considering the problems created by the recent extension of crop specialization, that not all development of this character is sound. In the war period much land was planted to grains which had better have been left in grass. In certain areas where specialized farming has been attempted the seasonal hazards are so severe as not to be sufficiently compensated by the profits of good years. What I have said as to the desirability of

adapting credit conditions to specialized farming applies only to districts where that type of agriculture has a reasonable chance of success. Specialized farming, in short, ought to be pretty definitely based on assurance that long-time crop prospects, coupled with the saving in production costs that specialization permits, adequately offset the inevitable risks and losses of the enterprise.

Increased Efficiency Promoting Prosperity

The increased efficiency that has resulted from the spread of improved machinery and larger power units, and the wider application of improved practices in American agriculture since the war, will in the end be a strong influence in restoring agricultural prosperity. When efficient practices are not in general use in all competing countries, the country first adopting them has a great advantage. Nevertheless we must not forget that the gain accruing to the agriculture of the United States as a whole from rapid technical progress is accompanied by loss, and perhaps failure, for individual farmers who can not keep up with the advance. Increased efficiency resulting in an increased output per worker may necessitate a reduction in the number of farmers. Rapid economic readjustments are always painful for some of the producers involved. Our more progressive farmers are selling or slaughtering their poorer farm animals and breeding from the better stock. They are using better seed, adopting better crop rotations, increasing their yields per acre of certain crops, and making heavy investments in power machinery. Those who can not follow this example find their position increasingly difficult.

This is shown by certain problems that have arisen in the Cotton Belt through the rise of large-scale methods of cotton growing in Texas and Oklahoma. In the older cotton States thousands of farmers are finding that periods of technical progress in agriculture are also periods of keener competition. Crop enterprises like cotton growing, in which American production dominates the world market, feel such conditions much more keenly than others—wheat growing, for example, in which our contribution to the world's supply is a relatively small part of the total. In the decade from 1910 to 1920 the annual cotton acreage in the United States was about 30,000,000 to 35,000,000 acres, with no upward trend apparent. Then came an enormous increase. Between 1922 and 1926 our cotton area increased from 33,000,000 acres to nearly 48,000,000 acres. This year, according to an estimate made in October, nearly 41,000,000 acres were harvested. Such expansion obviously implies keen competition in raising cotton.

Increase in Texas and Oklahoma

Although cotton acreage underwent expansion in the Cotton Belt generally between 1922 and 1926, the increase was most pronounced in Texas and Oklahoma. In the Eastern States part of the increase resulted from the resumption of cotton growing on lands that had gone out of cotton in the preceding period of low returns and high production costs, due to the boll weevil. Much of the increase in Texas and Oklahoma, however, was on virgin land formerly in cattle ranges. In the newer cotton areas of Texas and Oklahoma methods of production have been developed with which the older cotton States

find it difficult to compete. The land is level, farms are laid out in regular fields well adapted to the use of large machines, the soil is friable, easy to work, and comparatively free from weeds, and much of the area is not infested with the boll weevil. Under these conditions one man, using large implements and large power units, can plant and care for 75 to 150 acres of cotton, usually without hiring labor up to the time of picking. In the Piedmont district and in the Coastal Plains section of the eastern Cotton Belt the usual area handled per man is 10 to 20 acres of cotton and a similar acreage of feed crops.

In 1926 the cotton sled or stripper came into general use for harvesting cotton in parts of western Texas and Oklahoma. With this device one man can gather as much cotton in a day as 8 or 10 men can pick by hand. Most of the sleds used last year were crude and did not save all the cotton grown. Moreover, the cost of ginning sledded cotton was usually higher than the cost of ginning hand-picked cotton. Nevertheless, under the conditions that prevailed at that time, with cotton low in price and harvest labor dear, harvesting by the sled had a marked advantage. In all probability this mode of harvesting cotton in the newer cotton areas has come to stay, at any rate pending the development of a better method. Low-cost methods of growing and harvesting cotton in this region have reached a pitch of efficiency which may enable the farmers there to earn profits even in years of comparatively low prices. Accordingly, crop enterprises in the older cotton States may have to be readjusted somewhat. It is fortunate, therefore, that opportunities exist for some cotton farmers who have been devoting all their energies to cotton to turn to other crops and make cotton a relatively less important part of their business.

Changes in Wheat States

Significant changes have appeared likewise in the wheat-growing States. Wheat prices since 1924 have permittted or encouraged an expansion of wheat production in some regions. The area of winter wheat sown in the United States increased from 40,000,000 acres in 1924 to nearly 43,000,000 acres in 1926, and farmers reported this fall an intention to sow about 48,000,000 acres. In the last three years the farm price of wheat has averaged $1.28, $1.46, and $1.23 a bushel. These prices are compared with 92 cents for the marketing season 1923–24, and a pre-war average of 89 cents. In relative purchasing power, however, wheat has averaged lower during the last few years than before the war. It seems, therefore, that under certain conditions wheat production is being maintained or expanded in the United States at relatively lower prices than before the war.

Recent changes in our wheat map throw some light on the nature of these conditions. As already noted, the recent expansion appears in the new lands of the Great Plains region. Elsewhere the acreage is contracting. East of the Mississippi the acreage in wheat in 1924 was only 10,000,000 acres, compared with 12,000,000 acres in 1909. Recent expansion in our winter wheat acreage is almost entirely accounted for by increases in acreage in Nebraska, Kansas, Oklahoma, and Texas, in which States the wheat area increased from 18,500,000 acres in the fall of 1923 to 22,600,000 acres in the fall of 1926. Spring

wheat acreage in western North Dakota and Montana has undergone expansion likewise, offsetting reductions elsewhere.

In these areas wheat production is stimulated by the combination of cheap lands, improvement in methods of using such lands, more extensive use of machinery, and ability to produce high protein wheat which brings a premium on the domestic market. The tractor and the small combined harvester-thresher have been powerful factors in this development.

Eastward March of the "Combine"

In 1927 a large part of the grain in many sections where expansion has been taking place was harvested by the "combine." Half the wheat in Kansas was harvested in this way. The machine, a small prairie type of which was introduced in the Great Plains region about 10 years ago, enables two men to harvest from 400 to 500 acres of grain in 15 days of actual work. Combine harvesting is estimated to reduce the amount of labor required for harvesting and threshing 400 acres from 120 days of man labor to 30 days. Where conditions are best adapted to combine harvesting its advantages are striking. In the Great Plains region, according to field studies made by the department in cooperation with State experiment stations, the combine lowers the cost of harvesting and threshing, reduces the amount of labor required, shortens the harvesting and threshing period, and reduces waste of grain. Practically eliminating the need for transient harvest help, the machines economize household labor as well as field labor, adding materially to the savings. Combine harvesting is rapidly spreading eastward. In Illinois this year more than 300 combines were used. Indiana farmers used more than 50. Combines have also been introduced into Pennsylvania, Delaware, and Virginia.

All this technical progress has raised the question of the relation between increased efficiency and the prices of farm products. It has been suggested that the advantage of increased efficiency to the farmer may be largely offset through increased total output and reduced prices per unit of product. This is a problem which demands consideration. It may sharpen the necessity for a better adjustment of production in agriculture and for a better relationship between the agricultural population and other groups. There can not, however, be any justification for lessening the effort to attain increased efficiency. Such effort may return a diminishing total reward as the percentage of efficient producers increases, but the gain probably never vanishes altogether, and for the pioneer in efficiency it is substantial. Efficient methods have to be applied almost universally before their benefit goes mainly to the consumer. In the case of crops like cotton and wheat, the prices of which are determined in the world market, it is especially important that the highest possible level of efficiency be maintained by American farmers. Undoubtedly, however, progress in efficiency which causes production to keep pace with or to outstrip consumption calls for compensating adjustments in our agricultural system. Under present conditions it is probably unwise to bring more land into use, and I shall have more to say on this question later. While continuing our efforts to obtain increased productivity per worker, we should do

what is possible to prevent unnecessary expansion of crop acreage and to increase the income of agriculture by better adjustment of production and marketing.

COOPERATIVE MARKETING

Changing methods of marketing effect progress in agriculture as surely as do changing methods of production. New conditions demand new marketing machinery. Concentration of population in large centers and the development of highly specialized commercial agriculture make necessary an integration of marketing and production. Cooperative marketing is the means which farmers have found most helpful to this end. The introduction of modern machinery and production methods in growing wheat or cotton effected no greater improvements, comparatively speaking, than some of the larger commodity cooperative marketing associations have effected in handling butter, citrus fruits, or other products. Increasing complexities of consumer demand are being met by improved marketing services rendered by farmers' cooperative marketing organizations.

During 1926 approximately 2,000,000 farmers transacted about $2,500,000,000 worth of business through their own cooperative associations. The volume of business handled was about the same as in 1925, with perhaps a slight increase. Advances in the volume of business and in the number of members of cooperative associations, however, have not been rapid since 1923. It is rather in their increasing efficiency and stability that cooperative organizations show their most impressive signs of progress. Much has been learned and much has been accomplished in agricultural cooperation since 1920 and 1921, when the present revival of the movement started in this country. It will be useful to examine the extent and significance of this progress.

Postwar Cooperative Experience

In 1920 and 1921 a number of large-scale cooperative associations were formed almost overnight. Their members, for the most part, had no experience in cooperation; problems of marketing were strange to their directors; and their managers, even though experienced business men, were not familiar with the peculiar difficulties and responsibilities involved in the management of a cooperative organization. Many of these associations began to operate with no clear idea of the problems they would encounter. Merchandising and financing policies were only vaguely defined. Many members believed that products could be sold on the basis of monopoly control of the supply rather than by service to customers. There was in many instances an implicit faith that forms and legal remedies would prove substitutes for membership loyalty and business efficiency. That the large majority of these associations have continued to operate is a tribute to the loyalty of their members and the intelligence and adaptability of their management.

The large-scale associations of the present day are in nearly every case pursuing the policy of (1) offering marketing service adapted to the needs of their members, (2) standardizing and improving the quality of the products they handle, and (3) developing efficient merchandising, based on service to their customers and knowledge of

the forces of supply and demand. An illustration or so will serve to show the advances that have been made.

The cotton associations, for example, have adjusted their contracts so as to allow their members to choose the type of service best suited to their conditions. If a member is unable to sell his cotton in the seasonal pool established by each association, he may select the day or month that his cotton will be sold, and will receive the average price of that day or month for the actual grade of cotton which he delivers.

Cooperative Gins Established

The cotton associations, likewise, are taking the first steps in the development of cooperative gins, that is, their plan includes furnishing their members ginning, as well as marketing, service. They are developing also the sale of their cotton direct to mills, so that eventually the associations will perform or control all marketing functions necessary to carry cotton from the farm to the spinner.

The extent to which an association shall extend its functions depends, of course, on whether it can perform these services more efficiently than private middlemen. There are many middlemen agencies giving services which, in their field, would not be improved if they were assumed by a cooperative organization. Private middlemen will continue to perform these functions just as long as the organized producers are convinced that their cooperative associations can not perform them more efficiently. The existence of cooperative organizations stimulates more efficient service from all middlemen agencies.

In their merchandising policies, cooperative associations have made striking advances. The theory that monopolistic control of the supply of an agricultural product is feasible, or that such control, if obtained, solves the marketing problem, is no longer held by informed cooperative leaders and is dying out among the rank and file of the membership. In quite another sense, however, the associations have discovered that they are able to exert a measure of control over the prices at which their products are sold, and that their operations must be reckoned among the price-making factors. The large-scale cooperative assumes this position because, first, a strong selling agency with a knowledge of values is substituted for disorganized, uninformed selling of producers or small organizations. It obtains better distribution of the product; it stimulates demand by improving the quality of the product, by advertising, and by educational work with the trade; and finally, because it is a dominant factor in the industry, it is able to eliminate wastes and needless agencies at country points and in the terminal markets. All these things influence the price at which the product enters into consumption and the net returns to the producers.

Canadian Wheat Pools

The progress of our neighbors in the Canadian Northwest is an outstanding example of the development of efficient cooperative service. The Canadian wheat pools, organized in 1923, marketed last year practically 200,000,000 bushels of grain, over 52 per cent of the crop in the three northwest Provinces of Canada. These

pools have developed their own country elevator system, which has resulted in improved service and savings in local handling charges to their members. They own and lease large terminal elevators. The profits accruing to the members of the Saskatchewan pool from the operations of their terminal elevators exceeded $600,000 for the 1925 crop. The pools also have created a central selling agency, through which they market approximately 75 per cent of their grain direct to domestic and foreign mills, or through mill brokers in foreign countries. In other words, they are developing a broad service for their members, extending from the local elevator, through the terminal markets, to their customers, and are giving the producers of grain the savings of large-scale operations and the informed, efficient management which large-scale business is able to obtain.

Our farmers similarly have demonstrated that they can conduct large business enterprises successfully. More than 150 cooperative associations in the United States each handle business exceeding a million dollars annually. In practically every section of the country cooperative organizations are setting new standards in efficient marketing. The operations of these associations, it is true, are in the hands of skilled men who are not farmers, but marketing specialists. The policies of the organizations, however, are shaped by boards of directors who are producers, and the organizations are successful because the directors have the capacity to formulate sound policies and the intelligence to leave their managers free to carry out these policies.

Large-Scale Operations Essential

Prominent in the development of cooperative marketing at the present time is the formation of large-scale organizations and the enlargement of organizations already in existence. This development is necessary and desirable. Cooperatives must meet the competition of large and well-organized business enterprises, and must have, therefore, whatever efficiency and economy may be obtained through the formation of large operating units. Agencies dealing in farm products must have volume, and they will more readily make contacts with large cooperative units. There is some danger that when emphasis is placed on the development of a big business by business specialists, the control and participation of the farmers may become remote and uncertain. That danger must be resisted, and the fundamental principle of producer control safeguarded. I am confident, however, that this will be done.

NATIONAL FARM LEGISLATION

Proposed national farm legislation has been much discussed in the last few years. Many of the proposals made are fundamentally unsound. Nevertheless, I am confident that the study and discussion devoted to this question have been, on the whole, beneficial. The public has gained a better understanding of farm problems, and much helpful legislation has been enacted, including the intermediate credits act, amendments to the Federal land bank act, the Capper-Volstead Act, the packers and stockyards act, the cooperative marketing act, and the Purnell Act.

A large part of the farm problem—which in fact consists of many problems—must be solved by the individual and cooperative efforts of the farmers themselves. However, there is need for legislation to give further encouragement to large agricultural business organizations owned and controlled by farmers and managed by strong business executives chosen by the producers. In my last annual report I gave at length my reasons for believing that agriculture needs this type of business organization. Here I shall merely summarize my view.

Major farm products and many minor ones are no longer marketed largely in the locality where they are produced. They are sold in distant markets in competition with products from other parts of the country and even from other nations. Hence the farmer is more dependent on the market than formerly. He produces for sale and buys most of what he needs. Forces of national and world-wide scope determine the prices of his products and materially affect his economic position.

Over these price-making forces the individual farmer has no control. Even at best it is difficult for him to alter his production practices because of the limited adaptability of his land and equipment and the varying influence of the seasons. Moreover, farming is done in small units scattered over a wide area. These conditions make united action difficult. But I am convinced that united action is possible, and that it is the greatest single need of agriculture to-day.

This need is generally recognized. Opinions differ, however, as to means of meeting it. Some would assign the task of directly controlling this or that phase of economic life to the Government. They would have the Government either merchandise farm products or enter into agricultural business in some other way. I need not reiterate my opposition to this view. Such a policy would be detrimental to the farmers and in the long run would jeopardize the legitimate functions of Government. I believe that what is necessary can be obtained by the joint effort of organized farmers, with the Government giving such assistance as it may safely give and protecting the public interest by laying down broad rules of policy. This would preserve the spirit of self-reliance and self-help which has been the mainspring of our progress and at the same time promote the unity of action that modern economic conditions demand.

Commodity Basis of Organization

The type of business organization needed I discussed in my last report. I shall merely mention it at this time. We should center attention on the problem of organizing the producers of major farm commodities. Organizations should draw membership mainly from producers in whose scheme of farm management these major products are prominent parts. In this way a natural bond of common interest is established at the outset.

Although the form of organization might vary with the conditions peculiar to each major crop, in principle all such organizations should be the same. Producers in each locality should unite in a local unit, whether organized around a cotton gin, a shipping association, a creamery, a local elevator, or any other appropriate unit. Federation of these locals into regional and national associations

should follow. The object would be to exercise a stabilizing influence in the market, and to market products efficiently. Such organizations can not be developed in a day, but their growth can be accelerated by proper encouragement.

However, Governmental assistance should be given only in response to a demand for it from the producers. It would be futile for the Government to set up organizations in behalf of the farmers without their interest and initiative. Success in such efforts would necessitate some readjustments in our present machinery for agricultural marketing. Some concerns now in the business might have to drop out, and others might find their affairs less profitable. But inconvenience occasioned to individuals by successful cooperation is part of the price of progress. We should endeavor to minimize it without throwing obstacles in the way of advancement. In a sense this problem is analogous to that arising from technical progress in production. Labor-saving machinery and other improvements have often been vigorously opposed by workers fearing loss of their jobs. Yet, such improvements have increased the productivity of labor, and have become the foundation of high wages. I am confident that the type of business organization I have outlined for agriculture would benefit the country in a similar manner.

Adjusting Production to Demand

Such organizations would be helpful not only in the merchandizing of products but also in adjusting production to demand. I believe the time will come when farmers' cooperative institutions will be as firmly established as our great organizations of industry, transportation, and labor. Then the farmer will have more control over his business and more influence in matters of national economic policy.

If these cooperative organizations would help agriculture and be generally beneficial to the country, their development should be encouraged. They are now "infant industries." It has long been our concern to encourage the growth of industry. This policy has been an important reason for our protective tariff, under which, with the assistance of science and invention and the initiative of American business executives, we have become industrially preeminent. It is entirely consistent with established American policy to foster a beneficial agricultural movement in its early stages.

One of the functions of farmer-owned business institutions handling major farm products is to minimize the price fluctuations that result from recurring surpluses and shortages. The commercialization of agriculture and the relatively inelastic demand for some major farm products, together with the necessity which many farmers are under to sell their crops immediately after harvest, have made the question of surpluses increasingly important.

Variations in production from year to year are due to changes in acreage and to variations in yield. Since the latter come mainly from seasonal conditions, they are largely beyond the farmers' control. From 1905 to 1925 variations in yield per acre accounted for 60 per cent of the fluctuations in cotton production, with the remaining 40 per cent due to variations in acreage. Variations in production due to yield per acre of certain other crops were: Corn, 85 per cent; oats, 63 per cent; and tame hay, 47 per cent. It is obvious from

these figures that fluctuations in production, with resulting variations in prices, are a hazard of farming which is to a large degree unavoidable. In view of the connection between this condition and our economic life as a whole, I believe the Government should take cognizance of it and help to minimize the effects of surpluses and shortages. I believe that the public's responsibility in the matter could well be met by concrete assistance to properly organized farmers' business institutions.

Credit Difficulties Complicate Problem

Crop surpluses are often a more serious hazard than they need be, owing to credit difficulties. Many farmers are heavily in debt as a result of the postwar depression in farm prices, and because of speculative plunging during the boom which ended in 1920. Their obligations, along with short-time production loans, are pressed for payment. Consequently many producers are obliged to sell their crop as soon as it is harvested, regardless of the price offered. This, I am sure, is an important reason why the cotton producers sold more than 60 per cent of last year's bumper crop from October to January, despite the fact that the farm price of cotton on the average was less than 11 cents during that period. This problem deserves more attention than it has received.

Mortgage credit is now generally available on reasonable and suitable terms to farmers in all parts of the country, but the same can not be said of farm credit for production purposes. Farmers in many sections, and especially in the South, continue to pay unduly high rates of interest for production credit, and are embarrassed by the early maturity of the loans, which causes precipitate marketing at harvest time. Country banks have availed themselves of the rediscount facilities offered by the Federal intermediate credit banks only to a limited extent. In certain sections agricultural credit corporations have been of service in obtaining production and marketing credit from the intermediate credit banks. But such facilities are by no means generally available.

Lack of proper credit facilities has also retarded the development of orderly marketing through cooperative associations. During the past year rediscounts of farmers' notes have been available to banks and credit corporations at a rate of 4¾ per cent, making the rate to the farmer and rancher on such loans from 6 to 7¼ per cent, and direct loans to cooperatives have been made at 4½ per cent. Nevertheless, the benefit of these intermediate rediscount and loan rates has reached only limited numbers. Furthermore, in certain agricultural sections, banking facilities have seriously broken down, and local credit facilities have been even less adequate than usual. Bank failures have been numerous in the west North Central and South Atlantic groups of States.

Extension of Merchant Credit

Much of the production credit needed by southern farmers is extended by merchants rather than directly by banks or other credit institutions. Merchant credit is usually much more expensive and is in other respects less satisfactory than cash credit. Although in

the last year or two there has been some increase in the direct use of banks and credit corporations by farmers as against the practice of purchasing on time from merchants and dealers, the latter method is still too common. It would be better for all concerned if as a regular practice production credit could be obtained direct from banks or other specialized credit institutions and purchases made for cash. Although bank credit for production purposes often costs the cotton farmer as much as 12 per cent, with 10 per cent a very common figure, merchant credit not infrequently costs 40 per cent or more when all charges in connection therewith are figured on an annual interest basis.

Whatever the source of production credit, the cost should be reasonable and the terms and conditions such that the farmer is not forced to market his crops immediately after harvest without regard to the state of the market. In reply to a questionnaire sent out in December, 1926, 3,431 cotton growers gave information as to the marketing of the 1926 crop. Of the above number, 2,639 reported that they marketed their crop as soon as ginned, and of those who thus sold from the gin 978, or about 37 per cent, gave their credit obligations as the reason for such action. Credit arrangements should not militate against orderly marketing. Facilities for production and marketing advances should be expanded and improved so as to avoid needless pressure for the precipitate sale of farm products to meet obligations incurred in their production.

Under existing provisions of law, one outstanding need in the field of agricultural credit can not be met either by the land banks or the intermediate credit banks comprising the Federal farm loan system. This is the need for relatively long-term mortgage credit to finance the plant and equipment of cooperative marketing associations. Private facilities hitherto relied upon have proved inadequate. Funds for the purchase of necessary plant and equipment for cooperative associations can not properly be provided by these associations on the relatively short-term basis for which such credit is at present obtainable. A more gradual and systematic liquidation of debt incurred for this purpose should be made possible by some form of mortgage credit running for a suitable period of years.

Largely a Credit Problem

Public responsibility to agriculture in helping to minimize price fluctuations due to unavoidable surpluses is, in a large measure, a problem of suitable credit to hold a part of the surplus crop off the market from one season or from one year to the next. Such assistance need not be a "subsidy" as some critics have called it, but an extension of public credit to help reduce that hazard of farming which is due to unavoidable fluctuations in production and consequently in prices.

As already suggested, national agricultural legislation has been emphasized so extensively in recent years that the public has almost overlooked the sphere of State legislation. In view of the fact that so much has been said in recent years about expansion of Federal influence and subordination of State authority, it is surprising that so little has been said about the sphere of the States in the field of agricultural legislation. A great deal could be done by the States

themselves to put agriculture on a stronger economic basis. This applies especially to State and local banking and to taxation and public expenditures in their relation to agriculture. Farmers in many of the mid-Western States would have been better off to-day had sound local banking prevailed during the war and in the postwar boom.

It is generally too easy under existing State laws to organize new banks. Lenient requirements as to initial capital, and the absence of administrative restraint in granting charters for new banks in communities already well supplied with banking facilities have created an excessive number of small banks. In 1920 the west North Central States had 72.2 banks for each 100,000 population and 19.7 for each $100,000,000 physical wealth, compared with 25.5 and 8 in the east North Central States, 32.2 and 16.6 in the west South Central States, and 15.3 and 4.6 in New England.

Many Districts Overbanked

With due recognition of the fact that the number of banks is necessarily larger on the per capita basis in the sparsely settled parts of the country than in the highly urbanized East, there is no denying the fact that many of our agricultural communities are overbanked.

Small banks, created under lax laws and inadequate restrictions, are often headed by men lacking the necessary training and experience. In times of prosperity, extreme competition in an overcrowded banking field leads to reckless investments and creates a condition of too easy credit resulting in extreme optimism and unwise borrowing. Stimulus to land speculation is one of the results, and land values advance beyond what is justified by returns. Debts thus incurred become a serious burden to the farmer, lead to bankruptcy of individuals, and cause numerous bank failures.

AGRICULTURE AND THE TARIFF

In considering legislation in its relation to agriculture I wish to refer briefly to the tariff. I discussed this subject in detail in my last annual report. Here I will merely reiterate my view that the tariff on agricultural products should insure the home market, as far as possible, to the American farmer. Many branches of agriculture derive substantial benefit from the tariff. It should be possible, however, by impartial study of the manner in which tariff duties affect different commodities, to devise means of increasing this benefit. Trustworthy statistics are not available to show the degree to which the advantages of the tariff to agriculture are offset by disadvantages due to its effect on the commodities that farmers buy. Any discrimination which may exist should be ascertained and corrected. This, I am convinced, would be welcomed by American farmers who, on the whole, want to be shown what their position is in our tariff structure.

As I said a year ago, I believe the time is coming when the tariff will be of more importance and more value to agriculture than to industry in the United States, since agriculture is becoming less and industry more dependent on foreign markets. In order to get the best results from the tariff, research should be undertaken to deter-

mine precisely what duties should be placed on farm products, article by article, to insure the home market to the American producer. It should be our aim to give agriculture protection against foreign competition in our markets equal to that enjoyed by industry and labor. In a protected market the benefits of efficient agricultural production and marketing will be greatly increased.

TAXATION AND THE FARMER

There has been no outstanding change in the farmer's tax problems in the past year. As this subject was discussed at considerable length in my last annual report, I shall devote little space to it here, although it remains one of the important farm problems.

Taxes on farm property in 1926 amounted to over $800,000,000. Other taxes paid by farmers to State or local units brought the total about 10 per cent higher. The Federal Government collected from farmers and corporations engaged in agriculture, in the form of income taxes, an amount estimated at $10,000,000 to $15,000,000. Thus farmers and owners of farm property contributed to the various governmental units in 1926 a sum only a little less than $900,000,000 through direct taxes. The total taxes collected directly from farmers in 1914 were estimated at somewhat less than $350,000,000. In the 12-year period from 1914 to 1926, the direct contributions of farmers to the support of the various governmental units have thus increased more than 150 per cent. Gross value of farm production increased only about 60 per cent during the years from 1914 to 1926.

During the past few years the department and several cooperating agencies have obtained reports on the relationship between the income from agricultural land and taxation. These reports have indicated that in many sections of the country taxes have on the average amounted to fully one-third of the net income. That is, after the owners of farm land who reported to the department have paid their other expenses and have made a small allowance for depreciation on their buildings they find it necessary to pay over 30 cents of every remaining dollar for taxes.

Causes of Increase in Taxation

Increases in taxation that have come in the past decade have three main causes: (1) Increase in population; (2) rising price level; and (3) increased demand for govermental services. The first two of these need little explanation. Many governmental expenses are increased as population increases. There is a normal addition to the amount of taxes that must be collected when population grows. When the price level rises, it is to be expected that such expenditures will increase, since most governmental expenditures are for articles or services that are bought on an ordinary commercial basis. These two causes of increase account, however, for only part of the rise in expenditures. The remaining increase consists mainly of the cost of new or increased services that governmental units have been called upon to supply. Expenditures for schools and roads represent a large part of this cost of increased service. The increased use of the automobile has made necessary vast increases in expenditures for roads. To condemn the general increase in governmental expenditures and to con-

tinue to demand enlarged services from the Government is a common inconsistency.

If the assessment of real estate bore some immediate relationship to the current income from such property, the farmers' tax difficulties would be decreased in those sections where at the same time other industrial groups had increased tax-paying ability. Readjustment of assessments is, however, under any conditions a difficult problem, and to try to secure an annual adjustment of assessments to conform to income changes seems to be attempting an impossible task. More can probably be accomplished by improvement in the present system of assessment than by a complete change to the income basis of taxing property, especially in those governmental units where agriculture is the only important industry and where the prevailing type of farming is such that agricultural income in general is mainly dependent on one or on a few crops. Unless the amount to be collected by taxation can be lowered materially, relief for the farmer in an exclusively agricultural section must take other forms.

Tax Relief for the Farmers

That local economies are possible in most sections of the country and that certain expenditures may be reduced without curtailing necessary public service, will be conceded by all who have studied local government. Waste should be eliminated, but legitimate functions of government should be adequately supported. Possibilities of lessening the farmers' tax burdens include: (1) Increased recognition of sources of tax-paying ability other than tangible property; (2) the spreading of the tax base over a wider unit; and (3) improvement of the system of assessment.

The general property tax was used in 1922 to raise 78 per cent of the total amount of revenue collected by the States and their subdivisions. There has probably been little change in the percentage since 1922. This tax falls mainly on tangible property, that is, on property that may be readily found by the assessor; and because the farmer's property is of that type, he bears a particularly large share of the tax. Other sources of ability to pay are reached in some places by State income taxes, by commodity taxes such as those on gasoline, by the various license taxes, and by corporation and business taxes. These are used chiefly by the State governments and are distributed to local units in relatively small amounts.

In many cases a local unit is now required to provide a service which, to a large extent, is regulated by State statute, and which has a social significance that is not limited to the district. This is peculiarly true of education. Owing to the movement of population from the country to the cities, the rural school child is potentially the citizen of some urban community. Should the movement continue, as it probably will for many years, a large number of the children now in rural schools will eventually be city dwellers. Education in youth is essential to good citizenship wherever the citizen may live. Hence, the cityward movement of population makes the standard of instruction given in rural schools a matter of more than rural concern. It appears also, from the fact that the number of children of school age per thousand population is greater in the rural than in the urban communities, that the rural population is

bearing more than its fair share of the cost of educating the rising generation. Increased contributions by the States to rural school districts would seem to be justified. The advantages of such a change to districts with little property to tax would be substantial. In years when such districts were affected by crop failures, local governmental services would be maintained without undue local hardship.

Exemptions Increased

Revision of the Federal tax structure in recent years has not only reduced the amount of taxes collected but has increased exemptions under the income tax to such an extent that relatively few farmers now pay direct taxes to the central Government, notwithstanding the general improvement in farm income since 1921. The farmers' tax problems are primarily State and local, and constitute one important field for State policy in relation to agriculture, a field which has been all but overlooked in recent discussion of farm legislation. Because of differences in economic conditions and in systems of taxation in the various parts of the country, no remedial measure designed to aid the farmer in the solution of his tax problems can be applied equally in each of the 48 States.

LAND-UTILIZATION PROBLEMS

Although the last agricultural census recorded a decrease in the crop land of the United States, the expansion of cotton growing in Texas and Oklahoma and of wheat growing in the Great Plains area shows that the impulse to bring additional land into cultivation must still be counted on as an important factor in American agriculture. In the recent past there has been a relative overdevelopment of agricultural land. More acres have been brought into cultivation than changing market requirements justified, not only in this country, but also in other parts of the world, and power machinery is releasing much land formerly required for forage. This has undoubtedly helped to prolong the agricultural depression, which has prevailed in countries with such widely different systems of farming as England and the United States, as well as in other countries. Recurrence of the difficulty will be less likely if we do what is possible to encourage restraint in the expansion of the farming area, and a better selection of lands to be farmed.

Overexpansion of agriculture in relation to the demand for farm products is in part an unavoidable result of uncontrolled economic forces, but these influences are often supplemented by Government policies for stimulating the increase of the acreage in cultivation. In some countries, of course, conditions appear to justify governmental policies for promoting expansion of agricultural settlement. Australia, Canada, South Africa, and Argentina are stimulating land settlement in connection with their encouragement of immigration. France and Italy are doing likewise in order to strengthen and develop their African colonies. In Germany, Italy, the Baltic States, and other countries of continental Europe, the reclamation of swamps and cut-over lands is encouraged, and extensive reclamation works are being carried forward in Egypt, the Sudan, Palestine, and various parts of western Asia. Many of the conditions which appear to

justify government promotion of land settlement in the other countries do not apply to the United States. Yet our homestead laws continue to promote the settlement of land unfit for settlement, and since the beginning of the agricultural depression there has been continuous agitation for new irrigation projects. A number of new projects or extensions of projects have been authorized by Congress.

No Scarcity of Farm Land

In this country we are not attempting the settlement of a colonial empire such as northern Africa. Although, like Canada and Australia, we formerly found it desirable to employ our land policy as a means of attracting immigration, we are now endeavoring to restrict immigration. Unlike some of the densely peopled countries of Europe, our output of farm products adapted to the climate is adequate, and we have no scarcity of agricultural land. Although the Federal Government has disposed of practically all the lands of agricultural significance formerly in the public domain, there is still a vast area of potential crop land in private ownership. This area is estimated at more than 600,000,000 acres. A large proportion of this is fair to good land in woodland areas where only clearing is necessary. Such land, as well as large areas of potential crop land in semiarid regions, awaits only a sufficiently stimulating price for farm products to be brought quickly under the plow. In fact, this privately held land exerts at times an unfavorable influence on agricultural prosperity. The owners, affected by the burden of taxes and other carrying charges, are naturally anxious to put it to early use either themselves or by sale to farmers. Temporary increases in farm commodity prices cause some of it to be brought into cultivation, and when prices fall there is no ready contraction in the new farm areas because of the difficulty of transferring the labor and capital put into them to other industries. Short-sighted expansion of the agricultural area in times of temporary prosperity is encouraged, moreover, by the potent influence of supersalesmanship exerted in the interest of land-selling agencies.

Stimulated Expansion Unnecessary

These considerations show that probably it will not be necessary, at least for a long time, to invoke public policy for the stimulation of farm-land expansion in the United States. When farming is sufficiently profitable, there will be plenty of land forthcoming. Much of the needed increase will be made available from the larger areas of cut-over land and semiarid land not requiring extensive reclamation, much of it already within the boundaries of farms. Indeed, experience has shown that when the outlook is sufficiently promising private enterprise can be depended on to reclaim new areas. Far more land in the United States has been reclaimed by private than by public initiative. Although at times private capitalists have shown some hesitancy about investing in reclamation bonds, yet it hardly seems necessary or desirable to employ Federal funds, except under very unusual conditions, to accomplish what private capital will not venture to undertake on account of the doubtful profitableness of the enterprise. There may sometimes be justifi-

cation for Federal participation in enterprises involving, in addition to land reclamation, such matters of national concern as water-power developments, flood protection, or international and interstate relationships. In such cases, however, Federal promotion of agricultural expansion should be incidental to other interests. Where the sole purpose is to provide new farm land, the need for new land should be very clear before the enterprise is undertaken. There is need for a comprehensive study of reclamation policies and of the reclamation projects now under cultivation or contemplated. When the time arrives to expand our agricultural area we will have the facts and know what to do.

The policy of giving settlers on Federal reclamation projects from 20 to upwards of 40 years to repay construction charges without interest constitutes an extensive subsidy to agricultural expansion. This subsidy, moreover, varies directly with the length of time legally allowed for the repayment of the construction costs, which has been several times extended and works a hardship on other farmers. It was estimated in 1923 that on the basis of the terms of repayment of interest then existing, the exemption of interest at 4 per cent amounted to nearly 46 per cent of the cost of construction. Since then the period of repayment has been greatly extended and the subsidy correspondingly increased. As no corresponding subsidy is enjoyed by private enterprise in the development and utilization of agricultural land, the settlers on Government projects are given an important competitive advantage.

Reclamation in South

In recent years it has been proposed to extend the Federal reclamation policy to humid areas of the country, particularly in the Southern States, for the drainage and clearing of land and the restoration of soils. Under this proposal an appropriation has been obtained for exploratory purposes, and a number of projects for reclamation and land settlement have been tentatively selected. This hardly seems a sound policy. A survey of typical drainage districts in the lower Mississippi Valley and the South Atlantic States made in 1926 showed that less than 40 per cent of the drained land in those areas was in cultivation. In some projects but little progress had been made in bringing the land under the plow. Such facts pondered in connection with census statistics showing that the acreage of land in harvested crops east of the Mississippi River decreased 15,569,343 between 1919 and 1924 scarcely support the plea for extending Federal land reclamation in that area. Federal activity in the promotion of farm land expansion seems particularly unwise when we reflect that a number of Federal reclamation projects are suffering seriously from depression aggravated by heavy overhead charges growing out of high costs of construction. On these projects large numbers of farmers have been in serious arrears with their payments. Moreover, the land in them is far from being fully utilized.

In general, proposals to enlist the funds and initiative of the Federal Government in stimulating agricultural expansion must cause concern to all persons interested in the farmer's welfare. With a huge reservoir of potential agricultural land, and strong forces tending constantly to stimulate expansion of the farm area, our land

problem at present is not how to force land under the plow as rapidly as possible but how to achieve a wise and economical allocation of our available land among major uses such as crops, forests, and extensive grazing, and in such a way as to make farming on that land profitable.

Help to Private Enterprise

Since the greater part of the unreserved public domain has been alienated, except the arid portion, our policy should take the form of investigation and helpful direction to private enterprise, supplemented in some measure by Federal and State acquisition of forest lands. There are great areas of cut-over land and semiarid land where the suitable type of use remains to be determined. At present it is largely unused or inadequately used for lack of a definite policy. This is the situation in a large proportion of the cut-over areas of the Appalachian Mountains, the Atlantic Coastal Plain, the Gulf Coastal Plain, the Highland River, the Ozark and Ouachita Uplands, the northern part of the Great Lakes States, and a considerable territory in the Pacific Northwest. Most of this land is in private ownership and its future utilization must depend largely on private enterprise; but the problem of utilization is such that it can not be worked out alone without public action. The determination, for instance, of the economic feasibility of using land for reforestation involves technical questions of silviculture and forest management which are beyond the resources of a large proportion of the landowners in these regions. Moreover, it frequently is bound up with public action to provide fire protection and to modify systems of taxation. When the alternative possibilities of agriculture and extensive grazing are involved, the problem becomes doubly difficult for private initiative to solve. In many parts of these areas it is probable that none of the uses mentioned can be profitably employed by private enterprise, and it is desirable to consider the advantages of establishing State or Federal reserves. A great deal of careful investigation is requisite in order to determine what parts of these great areas can be economically farmed or employed as range land, and by what methods and systems of organization; and what are the economic possibilities of reforestation by private or by public enterprise. This department is making a beginning in the development of such a policy and purposes its extension in cooperation with the States as rapidly as may be possible. I shall refer to these considerations again in discussing the forest situation.

MOVEMENTS OF POPULATION

In the last seven years the farm population of the United States has probably declined more than 3,000,000. In 1920, according to the census, the farm population was about 31,000,000. In 1925 the census showed a reduction to less than 29,000,000. An estimate made of the farm population as of January 1, 1927, put the total at approximately 28,000,000. This loss of farm population is commonly believed to be the result exclusively of unfortunate agricultural conditions engendered by the postwar depression. This is not the case. Undoubtedly the depression of the last few years has accelerated the loss of population from the country to the town. But the loss is

in large measure a product of natural conditions which do not necessarily indicate that agriculture is a declining business, but which are quite compatible with its progress and prosperity. It will help us to distinguish between the permanent and the temporary causes of the decline in farm population if we bear in mind the fact that there was a break in the continuous growth of our farm population as far back as 1910.

In all probability, according to studies made by the department, a decline in the actual numbers of farm population began in certain States as early as 1880. It began in other States in the years following 1890, and in still others as far back as 1900. From 1910 to 1920 a decline took place in a considerable number of States. It is therefore obvious that causes of this condition exist independent of the recent depression. A certain part of the movement is due to natural long-time adjustments between industry and agriculture. It is a normal trend which need not operate to the disadvantage of agriculture.

This normal trend was undoubtedly accelerated by the postwar depression. It is important not to confuse the effects of agricultural distress with the natural consequences of increasing farm efficiency and expanding industry. Conditions that make agriculture temporarily unprofitable inevitably cause an excessive withdrawal from it of capital and men. This is unfortunate not only for agriculture but for the Nation as a whole. It is accompanied by depreciation of farms and buildings. If the process goes too far, it will necessitate correction eventually at heavy expense. For this reason too much reliance should not be placed on the cityward movement of population as a means of restoring agriculture to a satisfactory footing. What is needed is a proper balance between agriculture and other industries, and it is as harmful in the long run to have this balance impaired through excessive loss as through excessive increase of farm population. In all probability one of the earliest signs of returning prosperity in agriculture will be a declining movement of population from the land.

Several factors in the situation, however, have no particular relation to war-time or postwar influences. Among them is the transfer to the city of work formerly done on the farm, as when laborious hand-labor processes are supplanted by machinery produced in factories. Labor saved in agriculture by the use of machinery is offset in part, of course, by the labor used in cities in producing the machinery. It is therefore not wholly lost to agriculture. In general, however, the mechanization of agricultural processes releases from the farm considerably more labor than is required in factories to produce the necessary agricultural equipment. There consequently tends to result a relative loss of country population which does not at all imply that agriculture is declining. As a matter of fact it is a sign of progress when a given economic result can be achieved with fewer workers.

Influence of Science

Another important influence in reducing the number of men necessary in farm work, and therefore in tilting the balance of population

in favor of the cities, is the advance of scientific methods in agriculture. Improved grains, vegetables, fruits, and livestock, improved management of soils, and improved protection against plant and animal diseases have the same effect in economizing labor as is produced by the displacement of labor by machinery. These forces, unless they are offset by a great increase in the demand for agricultural production, must necessarily affect powerfully the ratio between rural and urban population.

There is another factor, however, that we can not regard with equal complacency. When agriculture loses personnel through conditions that make the business unprofitable or through conditions that make country life unattractive, remedies are necessary. Many things that tend to make the farm seem less attractive than the city can be controlled. I have already discussed the necessity of getting for agriculture its proper economic status, its proper share of the national income. Progress in this direction is being made. It is also necessary, however, to develop a fuller and richer rural life, so that where economic reasons do not compel them, competent farmers will feel less temptation to leave the country. It should be possible to make country life so attractive that farmers will not want to leave it even after they become well off. Indifference to rural standards of living, which has injured many countries, is always unwise.

Whether the normal farm population increases or decreases, it is certain that the Nation will suffer if the quality of the population left on farms is lowered. Modern conditions make it more certain that we shall have a sufficient number of farmers than that we shall have farmers of the highest type. As a check upon the loss of intelligent farmers to cities, stress should be placed on the methods of consumption on the farm. Assistance must be extended to rural communities to achieve the highest possible standard of living on the incomes available. A certain percentage of our farm homes are already equipped with labor-saving devices, such as telephones, gas and electric lights, and good plumbing. Better adaptation of such facilities to rural communities would help greatly in increasing their use on the farm.

Need for Cultural Facilities

Much might also be done to provide better cultural opportunities. Farmers want education, recreation, entertainment, health facilities, art in public buildings, and comfort and beauty in their homes. Increased farm incomes are not the only thing necessary to give them command of these things. It is also necessary to improve the technic of rural consumption. Cities have technical experts in many lines to work out the technic of consumption on a high level for the urban population. There is no reason why a similar service should not be done for the farmers. As a matter of fact, the Government has authority to assist in research and educational work directed toward the betterment of rural life. In this work the Department of Agriculture is active. Efforts to equip the country with institutions for health and culture, and facilities for education and entertainment are as thoroughly worth while as the work done to promote farm efficiency and increase farm returns.

THE LOWER MISSISSIPPI FLOOD

A great flood in the lower Mississippi Valley, which did enormous damage in several States, marked the year 1927. Flood conditions really began to develop in August and September, 1926, when heavy rains fell in eastern Kansas and Oklahoma. Later these rains extended into Illinois and Indiana, so that instead of the usual low waters during the fall months in the middle and lower Mississippi Valley the river and many of its tributaries were at abnormally high stages for that time of the year. During the last week of December, extremely heavy rains in Kentucky and Tennessee caused the greatest flood of record in the Cumberland River, and very high waters in the Tennessee River. Many of the tributaries of the Mississippi remained at a high stage during the winter months, and heavy rains during March and April, followed by torrential rainfall from April 9 to 22 in the Arkansas, Red, and lower Mississippi Valleys, resulted in the greatest of all lower Mississippi floods. During the period from December 18, 1926, to April 30, 1927, the rainfall over the Mississippi basin was sufficient to cover the entire area of 1,251,000 square miles contained therein to a depth of 12.38 inches.

The overflow covered 18,269,000 acres, or more than 28,000 square miles, in the States of Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana. Of this area, nearly 4,500,000 acres were planted to crops in 1926. Of the crop land overflowed, 1,839,000 acres were in Arkansas, 1,112,000 in Louisiana, and 662,000 in Mississippi.

Flood Losses

The lower Mississippi Valley is primarily a farming section, with comparatively few large cities on the lowlands, so that flood losses were mainly agricultural. Definite estimates of flood damage are difficult to compute, as there must be included in the total such items as extra labor and material for strengthening the levees, the destruction of roads and bridges, damage to buildings, equipment, and supplies, the loss of prospective crops, suspension or loss of business on the part of retail and wholesale merchants, loss of livestock, and many others. Estimated livestock losses include 25,000 horses and mules, 50,000 cattle, 150,000 swine, and 1,250,000 poultry. Estimates compiled by the Weather Bureau from many sources indicate a total loss of between $350,000,000 and $400,000,000.

Relief to flood sufferers was extended primarily by the American Red Cross, voluntary relief contributions by the American people amounting to more than $16,000,000. In addition, various governmental agencies, such as the Army, Navy, and Coast Guard, aided in the relief work, contributing tents and supplies, boats for removing people and property from the flooded districts, airplanes for communication, and other service. The Weather Bureau made remarkably accurate predictions of probable flood stages at various points throughout the flod area, thus aiding greatly in the protection and rescue work and the saving of life and property. These predictions were based on many years' experience in estimating floods and accurate records of rainfall and river stages at a large number of points. The American Red Cross not only furnished shelter, food, and medical supplies to a large part of the 600,000 refugees but

supplied many of the farmers with feed for work stock and seed for planting when they returned to their homes.

Extension agents employed cooperatively by the Department of Agriculture and the State colleges of agriculture were extremely helpful in determining needs of farmers, in locating supplies of seed, in making suggestions as to the best crops to grow after the flood waters receded, and in organizing relief work. Home demonstration agents aided in planning the diet of the refugees, in giving instruction in the proper feeding of children and invalids, in instructing the women and girls in remodeling of clothing and refinishing of furniture damaged by the flood, in making provision for sanitation, and in many other ways.

Crop Production on Flooded Lands

The flood began in Missouri and Arkansas before the normal planting time for cotton but did not reach Mississippi and Louisiana until much of the crop was planted and growing. Continued wet weather for several weeks before actual flood waters reached these latter States, however, had greatly delayed planting. More than half of the cultivated land in the flooded area, or about 2,600,000 acres, is normally in cotton, about 1,100,000 acres in corn, 360,000 acres in hay, and 370,000 acres in other crops. Because of delayed planting and reflooding in some sections, it is probable that not more than 3,000,000 acres were planted this year, of which not more than half was in cotton. The necessity for late planting caused a shifting from cotton to corn, so that more than the usual proportion of the land was in corn and forage crops. Late planting and wet weather made the cotton crop especially subject to boll-weevil attack, with resulting unsatisfactory returns.

Fortunately, cotton growers in the lower Mississippi Valley can produce the longer staple cottons which can not be grown on the dry lands of western Texas and Oklahoma. There is a ready market for these long-staple cottons at fairly satisfactory prices, even in years when there is an oversupply of the shorter staples and poorer grades. The necessity for obtaining new stocks of planting seed this year made it possible for many growers to replace the poorer varieties with the better long-staple strains. Seed of these long-staple strains was in abundant supply and was very generally provided by the American Red Cross for farmers who were without seed and unable to obtain it from other sources. Without question the lower Mississippi Valley was planted more uniformly to good varieties of cotton this year than ever before. In much the same way it will be possible during the next few months to replace the less-resistant sugar canes in the flooded area with varieties which are resistant to disease. Stocks of these newer varieties, introduced and distributed by the department, are available in sufficient quantity to replant the flooded acreage, and arrangements have been made to finance their purchase by growers who lost their planting stock in the flood. The department and the State agricultural colleges are giving attention to the expansion of acreage of minor crops which can be produced with profit, and the introduction of new crops and farm enterprises which promise reasonable returns when substituted for cotton and sugar cane.

Credit Problems

The rapid expansion of cotton production in western Texas and Oklahoma in recent years, and the low price of the 1926 crop generally had placed cotton growers in the lower Mississippi Valley in a difficult financial situation before the flood occurred. Mortgage debt had increased materially since 1920 and an unusual proportion of the production credit was carried over from 1926 into 1927. As a result of the relatively large volume of renewals on loans and advances, banks and merchants would have found difficulty in extending normal production credit in 1927 if no flood had occurred. Losses resulting from the flood caused bank deposits to fall, which, together with the large volume of unpaid 1926 credits, reduced the loaning power of local banks to such a point that financing the crop where replanting was possible after flood waters receded became a serious problem even where ample security was available. At the suggestion of the Secretary of Commerce, who was extremely active in relief and rehabilitation work, credit corporations were organized in Arkansas, Mississippi, and Louisiana which aided materially in financing crop production. In areas where successful replanting and production were impracticable in 1927, bankers and merchants will no doubt find extreme difficulty in extending needed credit to farmers for the 1928 crop regardless of available security.

Those in need of credit in 1928 fall into two principal groups: (1) those in position to offer reasonable security; and (2) those who have little or no security except the crop to be produced or the animals and equipment to be purchased with such credit. The needs of the first group may perhaps be met largely through assistance extended by banks, merchants, and credit corporations in the form of loans and rediscounts. A number of credit corporations already exist in the flood area and the formation of additional corporations of this character will no doubt be effected during the next few months. Special consideration will of necessity be given by intermediate credit and Federal reserve banks in the rediscounting of agricultural paper in the affected areas. The reestablishment of normal conditions will necessarily require considerable time and rediscounts should be granted for as long periods as seem reasonably practicable.

For those having inadequate security to offer for loans on a strictly commercial basis, mortgage credit on crops, livestock, and equipment will of necessity be supplied with frank recognition of the possibility of losses. The losses which may result from the extension of generous credit on crop and livestock mortgages will not compare, however, with the losses which would follow failure to render such aid.

Creditors will of necessity exercise a lenient policy with reference to interest payments and obligations which mature before the flooded area can produce a crop in 1928. Where repayment rests on the borrower's opportunity to continue a producer, the interests of both the lender and the borrower will be promoted by such a policy. Where security margins are ample there should be no question about extension of further credit. The rich alluvial lands of the lower Mississippi and its tributaries, if protected from flood danger, have a potential value far beyond the obligations now standing against them. Leniency on the part of money lenders during this period of stress, and the refinancing of many plantations on a long-time amor-

tization basis at a reasonable interest rate will go far toward preventing heavy losses on the part of present owners and a general demoralization of the agriculture of the area.

Flood Prevention

The prevention of serious floods in the future is an agricultural as well as an engineering problem. While the major problem of preventing disastrous floods on the rich agricultural lands of the lower Mississippi River and its tributaries is primarily one to be solved by the engineers, farmers can contribute much to its solution by so handling their lands as to prevent erosion and delay the movement of flood waters. Terracing of all cultivated land except that which is practically level, the growing of winter cover crops, and the maintenance of an abundant supply of vegetable matter in the soil so as to increase its water-holding capacity will greatly reduce run-off and tend to prevent floods. This will not only benefit the people in the river valleys, but will be of even greater benefit to the farmers on the higher lands by preventing loss of soil fertility through erosion. Erosion not only lowers soil fertility, but the gullying of fields reduces the available acreage of cultivated land and pasturage, causes the rainfall to pass more rapidly into the streams, lowers the water table, fills the rivers with silt, and lessens the capacity and shortens the life of storage reservoirs.

In addition to the prevention of erosion on farms, much can be done to lessen the danger from floods by the maintenance of forest cover on steep slopes. Two-fifths of the drainage area of the Mississippi River was originally in forests, about half of which has now been cleared for agriculture. Maintenance of timber on the mountain slopes in the Appalachian, Ozark, and eastern Rocky Mountain highlands, either through public or private control, will aid materially in preventing future floods. Planting of trees on steep slopes on farms will utilize such lands to the best advantage and will materially reduce run-off.

Prevention of future disastrous floods is an imperative national problem. Not only is it necessary to protect some of our richest agricultural lands and the homes and property of hundreds of thousands of people, but, coupled with flood control, consideration must be given to the possibilities of storage, control, and utilization of flood waters to provide cheap water transportation and electric power. In the eastern Rocky Mountain and Great Plains areas a study of the storage of water for possible future use for irrigation is also an essential feature of a comprehensive flood-control plan.

SCIENTIFIC RESEARCH IN AGRICULTURE

It goes without saying that scientific research in the modern world is the basis of economic improvement. Great corporations and business organizations are developing research agencies on a large scale. It is estimated that the annual expenditure of this country for the application of scientific knowledge is about $200,000,000. Of this amount approximately $20,000,000 is expended by State and Federal Governments for the development of agriculture. Most of the balance is expended by industry for the scientific control and develop-

ment of improved processes based on research. In proportion to the total amount spent on research in other fields, therefore, the expenditure for agricultural research is not large. I have repeatedly urged the appropriation of larger amounts for the department's scientific work. This would be an immensely profitable investment. It would pay large dividends, not only to agriculture but to the Nation as a whole.

The department is now expending about $10,500,000 a year for research work. This is inadequate even for the efficient handling of projects already in hand. It is estimated that at least $15,000,000 annually is required to do well what is already being attempted. Important developments in new fields, of course, are impossible without additional resources.

Of the $20,000,000 expended on agricultural research in the United States, about half is contributed by this department and half by the various States. Contributions by the Federal Government to the States for research now amount to $3,360,000 a year. Under the Purnell Act, which went into effect July 1, 1925, these contributions will increase to an annual total of $4,320,000. Money expended by the States and the Federal Government for the application of science to agriculture has yielded large returns. No better proof that expenditure for scientific research is true economy could be desired than that furnished by recent developments in agriculture.

Results From Dairy Research

This department, for example, has taken a leading part in dairy investigations that have resulted in better milk, in the reduction of losses from spoilage, and in promotion of increased milk consumption. This work has been done by the department and the experiment stations at an estimated total cost, as far as the department is concerned, of $72,000. It is saving the dairy industry millions of dollars a year. Altogether, the department spends annually a little over $500,000 for dairy research. Savings made possible in one group of projects in this field are immensely greater than the entire cost of all the work done in dairy investigations by the department. In the department's Bureau of Animal Industry 23 research projects have been completed at a cost of $50,900. Knowledge resulting from these projects is repaying their cost many times over.

An Investment Opportunity

Opportunities open to the Nation for profitable investment in agricultural research are countless. Diseases and insect pests, for example, destroy annually about 20 per cent of our possible crop yields. Much of this loss could be prevented at a comparatively small cost. Other means of reducing costs in agricultural production through scientific discovery only await the provision of adequate funds to become available. It is therefore a hopeful augury that a good start has been made under the Purnell Act, which provides more funds for research by the State experiment stations. Under this act, though not required to do so, nearly all of the States provide, in addition to buildings, grounds, and equipment, appropriations equal to or greater than the Federal allotment, and the work undertaken is

carefully correlated by a joint committee representing the Department of Agriculture and the experiment stations. Special provision is made for research in agricultural economics, home economics, and rural sociology.

In the Department of Agriculture during the last year important changes have been effected in organization, in pursuance of a general policy to segregate research work from the work of law enforcement, whenever feasible to do so, and to provide the fullest opportunity for carrying on these activities with greater economy and efficiency by placing them in separate administrative units. Since cases of law enforcement must receive prompt attention, there is a natural tendency to give them precedence over less urgent though fundamentally important research work when both types of work are conducted by the same organization.

Accordingly all research work formerly conducted by the Bureau of Chemistry, the Bureau of Soils, and the Fixed Nitrogen Research Laboratory has been consolidated in one research unit designated the Bureau of Chemistry and Soils. Law enforcement work formerly conducted in the Bureau of Chemistry and by the Insecticide and Fungicide Board has likewise been consolidated in a single administrative unit designated the Food, Drug, and Insecticide Administration. This unit is charged with the enforcement of the Federal food and drugs act, the tea inspection act, the insecticide and fungicide act, the naval stores act, the import milk act, and the caustic poison act.

Department Units Merged

The unit heretofore designated as the Packers and Stockyards Administration has been merged with the Bureau of Animal Industry in order to harmonize the enforcement of the packers and stockyards act with the other regulatory work affecting livestock and to provide for better and more extensive cooperation and that intimate coordination of work that is best secured when the immediate administrative authority is vested in one executive.

These changes should facilitate the study of problems urgently demanding solution, such as the better industrial utilization of farm products, the utilization of farm wastes, the more effective control of disease and plant pests, the study of potential foreign pests and diseases with a view to preventing their entry into the United States, and the improvement of methods of crop cultivation.

One of the difficulties faced by the department in its effort to improve its research activities is the fact that commercial, industrial, and educational organizations offer better inducements to qualified research men than the Federal Government. Whatever the present law permits has been done to obtain and hold research men with the necessary qualifications. It has not been possible, however, to accomplish this object as fully as is desirable. It would seem that, if the scientific work of the department is to be placed upon the most efficient basis possible, the Secretary should be given more latitude to establish the type of organization and the positions necessary. In commercial work the salaries are from 50 to 100 per cent higher than in the Government service, and they are from 25 to 50 per cent higher in the better college positions.

The Government should at least be in a position to hold its own with the universities and the research foundations.

Entire Public Benefited

In urging better provision for agricultural research, I want to emphasize the fact that its benefits go to the entire public and not merely to the farmers. There is a mistaken impression that the Department of Agriculture is operated for the sole benefit of the agricultural industry. As a matter of fact, a large part of the work done by the department and a large part of the funds expended by it are devoted to the promotion of the health, prosperity, and well-being of the general public. Even expenditures that seem to be primarily for the benefit of the farmer usually result in benefits also to the whole population. This is obviously true of research activities which enable farmers to produce better crops and livestock, to reduce their production costs, and to market their products in a more orderly and efficient manner. Savings effected by such activities benefit consumers as well as producers. It is true of all the department's work, and particularly of its research work, that the ultimate beneficiary is the entire community.

It will be convenient at this point to notice a few examples of the way in which the department's work promotes the general welfare as well as that of agriculture. The largest item of money expended by the department is for the improvement of roads. Over $92,000,000, or 60 per cent of the total expenditure of about $153,000,000 which was charged to the Department of Agriculture during the fiscal year 1927, was spent for this purpose. Improved roads benefit alike the city dweller and the farmer, and, since the city population is greater than the population of the farms, the improved roads probably contribute to the cities a sum total of benefits that exceeds the benefits derived by the farmers. No factor is as important as highway improvement in reducing the cost of operating motor vehicles, and certainly nothing contributes more to the utility and pleasure derived from the automobile. Besides contributing nearly $83,000,000 for the fiscal year 1927 to the several States as Federal aid in road construction, the department expended directly about $9,000,000 on forest roads and trails. These forest roads and trails facilitate fire protection in the national forests, improve communication between towns located within and adjacent to the forests, and form essential links in interstate and transcontinental roads on which traffic would be seriously impeded were it not for the contribution and work of the Federal Government. Engineering studies made by the department are reducing road maintenance costs for the States, counties, and municipalities, as well as for the Federal Government, and therefore contribute materially to lightened tax burdens.

Tax Burdens Lightened

Besides contributing nearly $83,000,000 in the fiscal year 1927 to the several States as Federal aid in road construction, the department expended directly about $9,000,000 on forest roads and trails. These forest roads and trails facilitate fire protection in the national forests and carry a large tourist traffic in the national forests and national parks. Engineering studies made by the department are

reducing road-maintenance costs for States, counties, and municipalities, as well as for the Federal Government, and therefore contributing materially to lightened tax burdens.

Another example of work done by the department for the benefit of the general public is the Federal meat-inspection service. Two thousand inspectors, at an annual cost of more than $5,000,000, stand guard at stockyards and meat-packing establishments to see that livestock and meat-food products entering into interstate commerce are wholesome and fit for the table. In like manner, the enforcement of the food and drugs act, better known as the pure food law, protects the public against unwholesome or adulterated food and drugs. This work calls for an expenditure of nearly $1,000,000 annually. Under other appropriations the department examines tea entering the country, and passes, also, on the quality and effectiveness of disinfectants and insecticides. Under a new law passed at the last session of Congress, the caustic poison act, the department will be required to see that householders are protected by proper labels and warnings from the misuse of caustic poisons.

Importance of Tuberculosis Eradication

About $6,000,000 a year is now being expended by the department in cooperation with the States in a campaign to eradicate bovine tuberculosis. This campaign has materially reduced tuberculosis in cattle, resulting in more economical production and safer meat and milk. Through its Bureau of Home Economics, the department has been spending something like $100,000 a year in investigating foods and nutrition, household appliances, textiles and clothing, and household finances.

Weather Service

Everyone is familiar with the local weather forecasts made and published daily by the department's Weather Bureau. Few people appreciate, however, the far-reaching scope and importance of the work of this bureau. The department's weather forecasts often effect important commercial savings. Last year, for example, a building contractor reported saving $36,000 on one cement job by heeding a local frost forecast. Daily forecasts and special frost warnings for agriculture save large sums annually to fruit growers. Flood warnings are often of extreme economic importance, and in recent years a special service for aviation has been maintained by the depatrment. Transatlantic aviation this year was facilitated by weather service furnished by the Weather Bureau in cooperation with British, French, German, and Brazilian national meteorological offices. Officials of the Weather Bureau are preparing to organize a standard weather service to meet such needs.

The expenditures of the Forest Service last year aggregated approximately $24,000,000. Eliminating about $9,000,000 for forest roads and trail construction and $3,000,000 from national-forest receipts paid to States for county road and school purposes, practically all of the remaining $12,000,000 was applied to the administration, protection, and development of the national forests. While benefits from these activities have accrued to farmers through the protection of watersheds providing water for irrigation, through

free use or sale at cost of timber, through free grazing for milk and work animals, and, in other ways, this program of forest conservation and utilization has been of direct benefit to the public as a whole. Less than $75,000, or only a fraction of 1 per cent of the total appropriations of the Forest Service, have been expended exclusively for farmers, this amount being used cooperatively with the States to provide planting stock for windbreaks, shelter belts, and farm wood lots.

Expenditures Relatively Small

It is worth noting that the amount expended by the department during recent years for all purposes, including road construction, has been less than 4 per cent of the total annual expenditures of the Federal Government. The total expenditure of the department for the fiscal year 1927 was $153,000,000, including $92,000,000 for roads. Of the remaining $61,000,000, the sum of $8,760,000 was paid directly to the States under the Hatch, Adams, Purnell, Smith-Lever, and supplemental acts, for the support of research work at State agricultural experiment stations, and for agricultural extension work in cooperation with States, counties, and farm organizations. About $1,900,000 was disbursed for the acquisition of additional forest lands, and in forest-fire protection in cooperation with the States. Another fund, totaling about $3,300,000, consisted of payments to the States in the form of special road and school funds, and represented a part of the receipts collected from timber sales and grazing fees in the national forests. There remained approximately $47,000,000 as expenditures for what might be termed the ordinary activities of the department, in which category are included all of its research work and such services as the administration and protection of the national forests, the enforcement of regulatory laws, the eradication or control of plant and livestock diseases and insect pests, crop and livestock estimating, market news services, shipping-point and terminal market inspection service, and the maintenance of big game and bird refuges. A detailed analysis of the department's expenditures will be found at the end of this report, and a glance at this analysis will reinforce what I have said as to the wide distribution of the benefits accruing from the department's work.

ECONOMIC RESEARCH AND MARKETING SERVICES

Demand for facts on production and marketing of farm products continues to increase. The fact-gathering, production, and marketing-service divisions of the department are being taxed to supply the information asked for. Progress has been made in gathering the facts of production, market movements, and prices. A plan for decentralizing the crop and livestock estimating service has been adopted whereby much more of the primary data collected from farmers and others relating to acreage of crops, numbers of livestock, etc., will be gathered hereafter by the 39 field offices of the service. This will not include what are commonly called the "speculative" crops, namely, cotton, wheat, corn, and oats, except in the minor States. The decentralization has resulted in a material reduc-

tion in the clerical staff of the Washington office and a saving of time.

Changes in demand for farm products and the competition of new production areas have forced farmers to reorganize their work. Through studies and surveys of farm management and economic conditions the department has developed facts to aid farmers in making shifts in types of farming. For example, a detailed study of the agriculture of Idaho was made in cooperation with the Idaho Agricultural Experiment Station and other agencies. This called attention to an increasing demand for dairy products in far-western markets within shipping distance of Idaho producers, and aided them in expanding operations into the most profitable lines. Similar studies were conducted in areas near Billings, Montana, and in South Carolina.

The disastrous downward plunge of cotton prices last fall moved the department to begin a program of economic research to meet future needs. Congress provided some additional legislation to carry it forward. Through fundamental studies of demand it is hoped to determine the extent of uses for cotton at any given price. The plan also calls for classification of cotton by grades as well as by bales. New and extended uses of cotton will be explored. The demand for cotton is more than normally flexible. The aim should be a supply at a price which normally should compensate the grower.

Through studies of supply it is hoped to determine the actual production of cotton in terms of grade, staple, and character, and to determine the variation of the production from the world's requirements. Work has started in Georgia and in 27 counties in western Texas and southwestern Oklahoma. It is planned to follow another year with periodical estimates of grade and staple of all cotton ginned and an estimate of the carry-over as of August 1.

Technological studies of spinning utility will continue. Additional studies will be made of the characteristics of the fibers which give them utility and strength. A series of studies of the cotton markets is also under way. From these and related studies it is hoped that a body of facts may be developed which will suggest many improvements in cotton production and marketing.

A study of the apple industry started during the year, in cooperation with several State experiment stations and the Extension Service, gathered statistics of the ages and varieties of trees in commercial orchards in all the important apple regions. Analysis will indicate the trend of production in each section during the next 10 or 15 years. The department made studies of prices received by growers for different varieties, sizes, and grades, and collected information on the supply and demand in representative cities. All the information will be interpreted and presented to enable producers better to adapt production to the market.

The research work of the Division of Agricultural Cooperation has been well organized and is beginning to show helpful results. Two outstanding studies completed this year deserve mention. A survey of the prune industry of Oregon and Washington, undertaken at the request of cooperative associations marketing prunes and of other organizations, covered the markets and methods of distribution, factors affecting production, and the present and probable future

output of the product. The study now forms a basis for the development of a selling campaign.

This division also surveyed the economic factors affecting the production and marketing of milk in New England, at the request of 25 dairy cooperatives. The report pictures the principal economic conditions which face this industry. Other studies of cooperative marketing completed during the year are: A survey of the Canadian wheat pools; a study of the livestock cooperative associations; a survey of the marketing of dec duous fruits of California; a business analysis of the marketing of Pacific coast eggs; and a study of membership relations in cooperative associations.

In February a meeting of representatives of 29 leading wool-marketing associations, representing approximately 38,000 wool producers who market 30,000,000 pounds of wool, was called under the provisions of the cooperative marketing act. Following this conference, a representative of the department went to Australia and New Zealand to survey and analyze methods of wool marketing and to gather information applicable to cooperative marketing in this country.

Information service on foreign competition has been strengthened by the appointment of a representative of the department to the Orient, where he has made a survey of present and probable demands for American farm products in the Far East. That part of the world taken more and more of our wheat and other products.

Development of standards for farm products has continued. At the Pan American Standardization Conference in Washington last May, attended by representatives of most of the Pan American countries, the department made a special display of its work in standardization. Representatives of tht European cotton exchanges met in March and approved copies of the universal standards for American cotton. Sets of the universal standards were prepared and distributed.

Official standards for dressed beef and for wool top were promulgated. Permissive standards were issued for such diversified products as slaughter vealers, honey, and bunched shallots. Tentative standards for 19 different types of tobacco were placed in use. In connection with the administration of the United States warehouse act work was begun on tentative standards for canned foods.

The Meat Grading and Stamping Experiment

The Better Beef Association, formed through the efforts of several cattle breeders for the purpose of popularizing the higher grades of beef, proposed a class or grade stamp for a carcass or wholesale cut. The packers and the National Livestock and Meat Board cooperated. In May official beef graders began stamping prime and choice grade beef.

The service, started experimentally in nine cities, is new and is wholly on a permissive or request basis. Although the stamping is limited to the two upper grades—choice and prime—a total of 25,493 carcasses, approximating 14,021,000 pounds of beef, were graded and stamped to October 15, 1927. The experiment has revealed the possibilities of bringing quality of meat to the attention of consumers.

Inspection Services Grow

The inspection of fruits and vegetables at both receiving and shipping points increased. Offices in 40 cities provided receiving-point inspection. Inspectors passed on 32,794 cars of fruits and vegetables at receiving points and more than 8,000,000 pounds of fruits and vegetables and other foodstuffs were inspected for steamship lines. The fifth year of shipping-point inspection service continues to prove this service of benefit both to producers and shippers; it furnishes an unbiased report on the quality and condition of products, facilitates marketing, and safeguards their interests in cases of damage or disputes.

The Produce Agency Act

The Sixty-ninth Congress passed an act to prevent the destruction or dumping without good and sufficient cause of farm produce received in interstate commerce by commission merchants and others.

The regulations promulgated under this act designate two classes of inspectors who are authorized to issue certificates of "good and sufficient reason" under the act—(1) any authorized inspector of the United States Department of Agriculture under the farm products inspection law; and (2) any health officer or food inspector of any State, county, parish, city, or municipality.

Although this act went into effect on July 1, no funds were provided for enforcement. Many commission merchants, however, availed themselves of the inspection provisions by calling upon the fruit and vegetable inspectors to certify to the condition of worthless products.

Clearing Houses for Marketing Fruits

During 1926 in the Walla Walla-Milton-Freewater prune district there was started what is known as the "Walla Walla plan," which included the operation of a clearing house of market information for the prune growers and shippers. The shippers of nearly 95 per cent of the output each day advised the market news service representative stationed in the district of their quotation, sales, primary destination of shipments, diverted cars, rejections and allowances, cancellations of orders, etc. He then compiled this information and issued it in the form of a consolidated report to all of the cooperators. This daily exchange of information through an official agency tended to stabilize the market, create a feeling of mutual confidence among the shippers, improve distribution, and prevent the overloading of any of the consuming centers. A clearing house for California grapes, organized this season, was operated on similar lines.

Progress continued under the United States warehouse act, now in its eleventh year. Warehouses for tobacco, grain, wool, dried fruits, and, more recently, canned foods, are the principal warehouses registered under the law. Licensed tobacco warehouses have a capacity of over 500,000,000 pounds; wool about 28,000,000 pounds; grain, 36,000,000 bushels; and dried fruits about 8,000,000 hundredweight.

Market Price Analysis

In an effort to discover the influences of various factors in causing price changes of farm products, research has continued with respect to grains, cotton, livestock, and other products. The results of several such studies have been published and others are being completed. This type of research is helpful in outlining programs of production, so that farmers may be able to adjust production to probable demand. It is desirable to know more about the influences affecting markets, but these can be studied only by using statistics of the past. One objective has been to collect basic statistics running as far back as they were available, and to publish them in a form available to many workers. During the year a series of statistical bulletins has been completed. This type of research is necessarily slow, and must be continued over a period of years to be helpful, but the beginning has been made.

PLANT INDUSTRY INVESTIGATIONS

In my report for 1926 I referred to the department's studies on imported alfalfa and red-clover seed and to a recent amendment to the seed act based on information thus obtained. During the past year these studies have been continued. As a result of hearings held, an order was issued effective June 2, 1927, that alfalfa seed from Argentina should be stained 10 per cent orange red. The aggregate acreage in alfalfa in the area of the United States lying east of the Minnesota-Dakota line and north of the Tennessee-Kentucky line in 1924 was 2,400,000 acres. This territory imports alfalfa seed. Tests have shown that the Argentine seed would have been successful on only a small percentage of this acreage. In many cases the South African and Argentine alfalfas have been killed out completely the first winter, while hardy varieties have suffered no loss.

In the three years, 1924 to 1926, the acreage in the important alfalfa-producing sections of Kansas and Nebraska has declined by a little more than 9 per cent. Two factors appear to be involved—the use of unadapted seed and a newly recognized disease known as wilt. The exact share of each, or of factors at present unknown, in the dying out of alfalfa fields, is not yet clear. It seems certain, however, that a large part of the trouble has been due to the use of seed low in price but unadapted.

Red-Clover Seed Studies

No new staining orders have been issued during the past year covering red-clover seed. Field studies are under way to determine how far the regulations already in force meet the situation. Red clover is the most important legume in the northeastern United States. It is seeded, alone or with timothy, on more than 24,000,000 acres. In part of this area winter hardiness is of first importance. Where the winters are less severe, resistance to certain diseases is the controlling factor in securing and maintaining a stand.

During the past year studies have been under way to determine more nearly the adaptability of foreign seed. Work has also been started on domestic red-clover seed. The differences between red-

clover seed produced in various parts of North America are not so marked as in the case of alfalfa. Such differences exist, however. Canadian and Oregon seed, for example, have usually produced plants more susceptible to anthracnose than plants from Ohio seed, and the plants from Oregon and have commonly been less winter-hardy. It has been determined that strains long grown in one section may develop characteristic qualities either of winter hardiness or of disease resistance. But to place our knowledge of this subject on an experimental basis will take time.

Soy Beans

During the past year many new varieties of soy beans have been received from our agricultural explorers. Owing to the great variability of the soy bean and the marked capacity of different varieties for adaptation to new conditions, the receipt of these new varieties, which include a number from Manchuria, promises to be of great importance. The adaptability of the soy bean to new conditions is well illustrated by the Virginia variety. In the Ozark region of Missouri extensive tests failed to show any promising sorts till the Virginia was tried and found to succeed admirably on the less fertile Ozark soils. The range of local adaptability is extensive and the study of varieties must be carried on over a wide territory.

Cereals

The improved hard red winter wheat, Kanred, developed in cooperative experiments at the Kansas Agricultural Experiment Station, has replaced much of the former acreage of Turkey and Kharkof, particularly in Nebraska, Kansas, and Oklahoma. Kanred is resistant to stem rust, which in some years seriously reduces yields in parts of the hard winter wheat area. Over 4,000,000 acres of Kanred are now grown annually. Newturk, an awnless hard red winter variety developed in cooperative experiments in Montana, was increased for distribution in 1927.

Because of its susceptibility to stem rust, yields of Marquis, the most widely grown variety of hard red spring wheat, are often greatly reduced when this disease is epidemic. Kota, introduced from Russia by the department; Ceres, produced at the North Dakota Agricultural Experiment Station; and Marquillo, a new rust-resistant variety developed in cooperative experiments at the Minnesota Agricultural Experiment Station, are varieties adapted to the areas where rust losses are severe. Reliance, a hard red spring variety developed by the Department of Agriculture, is promising where rust is not serious. This latter variety was distributed for commercial growing in 1926 and 1927.

Bunt or Stinking Smut

Bunt or stinking smut is the most serious disease of wheat in the Pacific Northwest, where soil infestation makes complete control by seed treatment impossible. A red winter variety, Ridit, which is highly resistant to bunt, has been developed in the cooperative breeding experiments at the Washington Agricultural Experiment Station. Some 200,000 acres of Ridit were grown in 1927. Albit, a

bunt-resistant, white club variety, very similar in other respects to the important commercial variety, Hybrid 128, will be distributed to growers in Washington in the fall of 1927. Two productive, bunt-resistant strains, Oro and Regal, have been isolated from the Turkey variety in cooperative experiments with the Oregon Agricultural Experiment Station. About 300 bushels of the latter strain were distributed to farmers in the fall of 1926.

The rosette and flag-smut diseases of wheat were discovered in southern Illinois in 1919. Flag smut is especially serious in other countries where it occurs. Extensive experiments discovered wheat varieties which are highly resistant to or immune from either or both of these diseases and which are well adapted to the area where the diseases occurred. The Shepherd variety, developed by the department, is immune from both. This and other resistant or immune varieties are now so generally grown that these diseases are no longer a serious menace in the eastern United States, and field experiments with the diseases were brought to a close with the end of the 1926 season.

Cotton Improvement

The Acala variety is a new and superior type of upland cotton, first discovered in southern Mexico in 1906 in the course of explorations and experiments conducted by the department in Central America. The new cotton was acclimatized and tested in Texas, and found to be adapted to a wide range of conditions in the United States. It is one of the earliest and most prolific varieties of upland cotton, and produces better and longer fiber than other large-bolled varieties.

On account of its ability to produce good crops in short periods, the Acala cotton is suited to weevil-infested regions, as well as to short seasons along the northern limits of cotton production. Its upright growing habit is an advantage over the more spreading habit of the Texas big-boll varieties. This characteristic makes it easier for the grower to keep open lanes between the rows, so that fallen squares are dried by the hot sun, which kills the weevil larvae. Also, the cotton is easier to pick and fewer bolls are rotted by lying on the ground.

The fiber is of superior quality and length, attaining $1\frac{3}{16}$ inches under favorable conditions. Premiums ranging from 2 to 10 cents per pound are obtained for Acala cotton in communities that restrict themselves to the growing of this variety. In the Coachella Valley of southern California organized community production of the Acala cotton has been maintained since 1920. Several other valleys have since adopted the community plan and are growing Acala cotton exclusively.

Potatoes

Potatoes make a very large and important contribution to the food supply of the Nation. No other food crop, so widely and extensively used, passes directly from the producer to the consumer without fabrication. Potatoes are grown more universally and over a wider area of the country than any other vegetable crop. In certain regions where favorable growing conditions for a period long enough to

produce a marketable crop are the rule, an extensive commercial industry has developed based on seed potatoes produced in regions more adapted to their production.

Because of the large commerce in seed potatoes for use in those areas in which early potatoes are produced, special attention has been given by the department to the production of the varieties that give the best yields and sell for the best prices when grown in the southern growing regions. In the seed-potato-growing areas of the North, emphasis has been placed on the selection of high-yielding strains for seed stock to be sent to the South for the production of the early crop. It has been demonstrated, too, that seed potatoes grown in particular regions give better results under southern conditions than seed potatoes from other areas. As a result, the growers in particular regions in the Southern States arrange for their supply of seed potatoes from these particular regions. Seed-potato fields are carefully inspected while growing to detect and eliminate any plants infected with tuber-borne diseases.

Some years ago the Department of Agriculture tried to develop American potato varieties resistant to late blight, to which they are all more or less subject, by introducing, for breeding purposes, certain European varieties in which blight resistance was well developed. Various virus diseases attacked the seedlings produced in this experiment, making it necessary to devise ways of controlling virus diseases before these new seedlings could be developed sufficiently to carry out regional tests of their adaptability. This experience indicated resistance to these diseases is more important than resistance to blight. The greater problem will be to combine resistance to one or more of these diseases with resistance to blight, scab, and other parasitic diseases, and with regional adaptability.

Tomatoes

The department's horticultural work with tomatoes has been directed toward emphasizing the character and color of tomatoes especially adapted to canning and catsup making, and toward the development of pure strains of these sorts. The importance of the first-generation hybrid as a means of securing optimum yields of tomatoes under limited field culture and in greenhouses has been demonstrated. The selection of high-yielding strains of tomatoes, especially adapted for canning, is still in progress. Important advances have been made which promise to be of value to the canning industry.

The outstanding accomplishment to the credit of the department in connection with the tomato industry is the production of excellent varieties such as Marglobe and others which have proved so resistant to wilt, nailhead rust, and kindred troublesome diseases. Approximately 6,000 cars of Marglobe tomatoes were shipped from a single county in Florida in the winter of 1926–27. The Marglobe is also being adopted in other trucking areas and in the canning regions as rapidly as the seed supply will permit. Six other varieties of tomatoes, viz, Marvana, Marvelosa, Marvel, Norton, Columbia, and Norduke, developed by the department, are now in commercial use. These varieties are not only highly resistant to Fusarium wilt but also possess some resistance to Septoria leaf spot, early blight, leaf

mold, and nailhead rust. Moreover, their fruits are somewhat resistant to puffiness—a condition that causes considerable loss in Florida and other Gulf States as well as in Mexico.

Plant Disease Control

The three campaigns carried on by the Bureau of Plant Industry in cooperation with the States concerned, namely, citrus-canker eradication, blister-rust control, and barberry eradication to control stem rust of wheat, have made satisfactory progress during the past year.

In citrus-canker eradication, Florida reported the discovery of two infected orange trees in December, 1926, the first new infection reported in that State since March, 1925, indicating that the disease is well under control. Mississippi and Alabama are apparently free from canker, as no infections have been found in those States for several years. Louisiana has not reported any new infections, but a number of properties in that State are still classed as "infectious." In Texas the work is being concentrated in the southern part of the State, where heavily infected trifoliata hedges of long standing have been removed, with the result that conditions in that State are now better than at any time since the beginning of the campaign in 1915.

In white-pine blister rust control, scouting during the last year in the Northwestern States showed no further southward extension of the disease, but a marked increase in the amount of pine infection was found in the Olympic Peninsula, Wash., and near Nelson, British Columbia, indicating the certainty of a further extension of the infected area in the course of time. Invasion of the western white-pine forests of the Inland Empire and the sugar-pine forests of Oregon and California is delayed through the maintenance of quarantines and the eradication of the European or cultivated black currants. This plant has been eradicated in Montana and Oregon, almost completely eradicated in Idaho and Washington, and in California it has been eradicated from about half of the State. In the Eastern States the prompt application of control measures has progressed steadily, resulting in the protection of the white pines on 4,032,474 acres of land since 1922. The eradication of black currants and gooseberries in eastern white-pine forests is now progressing at the rate of over 800,000 acres a year.

In the nine years that the barberry-eradication campaign has been in progress more than 14,300,000 plants of common barberry have been destroyed in order to reduce stem-rust losses of wheat and other small grains. In the eastern States of the eradication area positive control of local epidemics of stem rust has followed the removal of these bushes, and in the spring-wheat States eradication reduced materially the losses from destructive epidemics.

Improvement of Sugar-Bearing Plants

The improvement of sugar cane and sugar beets with respect to high yield, hardiness, disease resistance, sugar content, and regional adaptability is an outstanding example of the amelioration of cultivated plants through scientific research. Unconscious selection of superior varieties has been going on for centuries, and planned work

along these lines also dates back for many generations. Early in the nineteenth century attention was focused on the improvement of sugar beets by mass selection. In recent years endeavors have been made to improve both sugar beets and sugar cane by the application of more refined methods resulting from a greater knowledge of the laws of heredity. In the improvement of sugar plants through breeding, increased sucrose content, increased tonnage per acre, resistance to disease, and earliness are among the qualities that have been kept in mind.

Preliminary results are promising. Sugar-cane varieties imported and tested by the department have almost completely supplanted the varieties formerly grown in Louisiana, some of which had been in continuous cultivation for a century or more. The most prominent desirable character of the new varieties is their resistance to disease. Incidentally, some of the disease-resistant varieties also mature earlier, are more tolerant of cold, and ratoon over a longer period. They are also prolific.

Several strains of sugar beets superior to those obtainable from commercial sources have been produced by departmental experiments. To make these strains available to American beet farmers it is necessary to cheapen seed production so that American producers can compete with Europeans, who now have a monopoly. A method involving the overwintering of the stecklings in the field has been developed, which gives great promise of producing seed at less than half the cost required in biennial seed production.

ANIMAL INDUSTRY

Conditions surrounding the production of domestic livestock, including poultry, are gradually being improved by a more effective control of diseases and parasites and by new discoveries in the field of animal husbandry. Noteworthy advances have been made in the last year in several lines of research having a practical application in livestock production. Satisfactory compliance with laws and regulations for the protection and promotion of the industry prevailed generally.

Foreign Maladies Excluded

Quarantine measures against foot-and-mouth disease proved effective during the year. This foreign livestock malady continues to be a serious national menace, however, and has demanded continued vigilance.

A report prepared by the department's foot-and-mouth disease commission, after investigations of the situation in foreign countries, confirmed the value of the quarantine-and-slaughter policy practiced by the United States in stamping out foot-and-mouth disease. Investigations by the commission showed also the extreme infectiousness of the virus. The utmost cooperation by all branches of Federal, State, and local governments is earnestly requested in excluding and combating foot-and-mouth disease.

European fowl pest, which gained temporary access to the United States in 1924 and was suppressed in 1925, has not recurred, though on several occasions the department's inspectors have investigated

reported outbreaks. In all cases the cause for anxiety proved to be a less serious malady than European fowl pest.

Besides maintaining the quarantine regulations previously in force, the department extended its veterinary supervision over imports. The inspection of scrap bagging is now included. Research has been undertaken to determine the effectiveness of various methods for sterilizing commodities that may carry infection. For instance, steam under pressure was found to penetrate loosely packed bales of bagging readily, but, on the other hand, bales of similar material packed tightly by powerful hydraulic machines, to obtain lowest shipping rates, resisted the penetration of steam heat for several hours. These investigations, besides helping to safeguard the livestock industry, illustrate the importance of technical research in connection with the enforcement of livestock sanitary regulations.

Progress in Eradicating Tuberculosis

During the year the cooperative campaign conducted by State, local, and Federal authorities to eradicate tuberculosis from domestic animals made exceptional progress. The Federal appropriation of $4,653,000 for this work was supplemented by still greater support from other sources. The combined State appropriations amounted to approximately $13,000,000, and numerous agencies interested in the suppression of tuberculosis among animals gave additional assistance in workers and funds. Public sentiment has supported this work so admirably that opposition has become largely of local and transitory nature. The available funds and favorable public attitude toward tuberculosis eradication made possible a large gain in the number of cattle tested, the number being in excess of 9,700,000. This was about 7 per cent more cattle than were tested during the preceding year.

Tuberculosis in Swine and Poultry

The suppression of tuberculosis among swine and fowls also received attention during the year. Since hogs are susceptible to the avian type of the disease, the successful development and use of a simple tattoo system of marking hogs facilitates this work among both swine and fowls. In conjunction with post-mortem reports on swine, the tattoo system is useful in identifying sources of swine and avian infection, particularly in areas nearly free from tuberculosis.

Among fowls, tuberculosis varies greatly in its prevalence in various parts of the country. Results of the year's work indicate that the disease among fowls can be detected only partially by physical examination and that, as in the case of the bovine form, the tuberculin test is needed to detect all diseased birds in a flock. The poultry industry is alert to the need for effective eradication methods and is cooperating with the department to that end.

Discovery Concerning Tuberculin

A fruitful field of research during the year was that of interrelated chemical and biological problems. Department investigators in this field made valuable contributions to knowledge concerning tuberculin,

the diagnostic agent used in tuberculosis-eradication work. The investigations disclosed two biologically active principles. The discovery is highly important in its bearing on methods of preparing and testing tuberculin, and promises to result in a more uniform quality of the product.

Tick Eradication

In the Southern States the eradiation of cattle ticks continues to make steady progress. During the year there was a gain of 12 counties and parts of 5 counties in the area released from Federal quarantine. The progress occurred principally in Texas, Arkansas, Virginia, and Florida. Of 985 counties in various Southern States that were quarantined when systematic tick eradication began in 1906, 248 still remained under quarantine at the end of the fiscal year. This important work may therefore be considered about three-fourths completed.

In spite of the excellent progress made there is still some misguided opposition, largely in areas that would derive handsome benefits from the suppression of this pest. Tick eradication is primarily an economic undertaking and the funds invested in it are ultimately returned to a community, with dividends, in the form of a prosperous livestock industry. Packing establishments, creameries, milk condenseries, and ice-cream factories have appeared in regions freed of the ticks. Such establishments provide good cash markets for meat and dairy products besides enabling the communities to be more self-supporting with respect to these commodities.

The floods occurring in the Mississippi Valley during the year aided tick-eradication work somewhat by depositing silt over large areas formerly infested, thus destroying the ticks in enormous numbers. Particularly in Louisiana the flood waters advanced the eradication of the pest. When restocked with tick-free cattle such areas should remain free from these parasites. The department's inspectors accordingly have urged that advantage be taken of this special opportunity to advance the completion of tick-eradication work in flooded areas. In such cases the expense of supervising restocking with tick-free cattle is but a small portion of the cost when an adequate number of dipping vats must be built and maintained to conduct the work in the customary manner.

Federal Meat Inspection

The Federal meat-inspection service continued to operate under the law providing for Federal supervision over meats prepared in establishments doing an interstate or foreign business. Inspection extended during the year to more than 70,000,000 animals, an increase of about 4 per cent over the preceding year. Conditions in the 863 packing establishments operating under Federal inspection were maintained on a high plane of sanitation, and there was general compliance with the letter and spirit of the meat-inspection law. Although the Federal meat-inspection service is operated very economically—about 6 cents for the average animal and all of its products—available funds were insufficient to meet growing demands for the service. It was necessary during the year for the department to refuse numerous requests for the inauguration of inspection.

Hog-Cholera Outbreaks Checked

The department has continued to supervise the manufacture of veterinary biological products produced for sale in interstate or foreign commerce. This activity is conducted under the virus-serum-toxin act of 1913, and includes also the issuance of licenses, permits, and certificates for manufacture, importations, and exportations. A record output of anti-hog-cholera serum occurred during the year just closed, being a result of the unusual prevalence of hog cholera in the fall and winter of 1926. Licensed establishments produced more than a billion cubic centimeters of the protective serum, or about 50 per cent more than in any former year. The quantity of hog-cholera virus was in corresponding proportion.

It is gratifying to report that outbreaks of the disease declined rapidly following the wirespread use of the preventive-serum treatment. This method of immunization, developed in the Bureau of Animal Industry, has been a dependable means of preventing and controlling hog cholera; and the experience of the year just closed shows its effectiveness in protecting the swine industry against the disease. Most of the deaths of hogs resulting from cholera occurred in herds whose owners had not taken the precaution to immunize them.

Meat Investigations

Extensive investigations to study the quality and palatability of meats were continued by the department in cooperation with 25 State agricultural experiment stations and other agencies. Approximately 1,000 cattle were used in the studies, of which more than 150 were slaughtered at the United States Husbandry Experiment Farm, Beltsville, Md. The revenue received from the sale of meat and meat products which remain after the investigations have been completed has returned to the Treasury each year a large proportion of the money appropriated for the experiment. During the last year the sale of products from Government-owned animals amounted to approximately $15,000, in addition to which about $35,000 was returned to State experiment stations which had shipped livestock or meats to the department for various tests and analyses.

Investigation of Animal Fibers

A series of experiments involving wool and mohair have yielded results of interest to the sheep and goat industries. Technical observations of the occurrence of the coarse fibers known as kemp in mohair have explained why kemp fails to dye readily. A comparison of fleeces from Angora goats of different degrees of pure breeding demonstrated the feasibility of eliminating or greatly reducing the occurrence of kemp by the proper selection of breeding stock. The importance of mohair in the textile industry and its wide public use in clothing and upholstery make the results timely as well as of scientific and practical value.

Poultry Investigations

The past year has been one of marked advancement in the department's poultry work. The feasibility of obtaining high egg produc-

tion in poultry flocks continues to be demonstrated at the department's farm near Beltsville, Md., where many visitors have observed the results. The average production of the department's poultry flock reached the highest point of any year. Two of the fowls laid 300 and 312 eggs, respectively. In addition to its regular experimental activities on poultry problems the department's specialists prepared an exhibit and arranged for other active participation in the World's Poultry Congress held at Ottawa, Canada, in July, 1927.

Animal Parasites

Excellent results obtained from the swine-sanitation system, devised by department workers for controlling roundworms of hogs, have suggested the possibility of controlling other animal parasites more effectively. In the case of sheep, which in the South suffer severely from stomach worms, drenching with copper sulphate solution proved an inadequate control measure. Light stocking of pastures was fairly effective as a control measure, but is not conducive to profitable sheep raising under ordinary farm conditions. Investigations are in progress to devise, if possible, suitable means for controlling stomach worms of sheep more effectively in Southern States.

Control of Rabies

The increasing prevalence of rabies in the District of Columbia and adjacent portions of Maryland and Virginia merits the attention of the public as well as of the veterinary and medical professions. As in former years the department pathologists examined and reported on specimens sent to their laboratories for examination. Pennsylvania and Virginia also contributed several cases. Of 236 suspected cases received for laboratory examination, 193 proved to be rabid. This large proportion draws attention to the existence of a menace that is purely the result of public tolerance. The rabid animals were chiefly dogs. The enactment and strict enforcement of muzzling laws are an effective means of reducing this danger to human and animal lives.

Veterinary Education

An impending shortage of trained veterinarians is evident from the reports of enrollment received from the 11 accredited veterinary colleges in the United States. The total number of graduates reported to the department at the close of the school year in 1927 was 115, which is the lowest number on record. The year also marked the closing of the last private veterinary college in the country, leaving the field at present entirely to State colleges.

The present number of graduates is scarcely enough to fill vacancies in the Bureau of Animal Industry alone. There is an additional field for competent veterinarians in private practice, in military service, and in the employ of State and city governments which need qualified men for a wide variety of inspection work. Although there has been a decline in recent years in the number of horses in the United States, the number of horses and mules on farms alone is still more than 20,000,000, in addition to which there is need for

competent veterinary service for cattle, sheep, swine, and other animals. The extensive campaign for eradication of tuberculosis and the present wide interest of the poultry industry in suppressing disease further broaden the veterinary field. Consequently, the veterinary profession seems to offer excellent opportunities.

DAIRY INDUSTRY INVESTIGATIONS

Records of associations for the improvement of dairy herds show that the margin between cost of production and income from the dairy herd becomes greater as production per cow increases. The problem, therefore, may be largely solved by increasing the average production per cow. This can be done most economically through the use of good purebred dairy sires. Dairy-herd-improvement-association records, tabulated and studied in the Bureau of Dairy Industry, show that almost any purebred dairy bull will improve a herd whose average yearly butterfat production per cow is below 200 pounds but that it becomes more difficult to increase yield as average production advances to higher levels.

In many districts of low production, scrub and grade bulls are widely used. By conducting scrub-bull-eradication campaigns, the department is assisting those districts to replace scrub and grade bulls by good purebred dairy bulls. Increased yields per cow follow.

In those districts, however, where average butterfat production is comparatively high the problem is not so easily solved. The records show that only about half the purebred bulls that were mated with cows whose yearly butterfat production was above 400 pounds per cow were able to increase the production of the daughters above that of the dams of the daughters. The sires that have already shown their ability to improve such a herd are the only ones that are at all certain to bring improvement when mated with cows of that class.

Sterility in Dairy Animals

Sterility in dairy animals, both partial and complete, causes losses to the dairyman that are probably as great as are caused by the more dreaded contagious diseases. Partial sterility, requiring animals to be bred a number of times before conceiving, indirectly causes great losses through lowered yearly production of milk. Most farmers breed their cows to freshen every 12 months. If the cows do not conceive for three or four months after the date of first breeding because of some form of sterility, they are likely to be dry three or four months longer than they should be, thus resulting in a loss to their owners during that period.

A problem confronting the dairyman is that of the fertility of sires. It is extremely important to keep good sires fertile as long as possible. The number of years that sires will remain serviceable varies, due probably to differences in management and care. Then, too, many farmers have made it a practice to slaughter bulls when they reach the age of 3 or 4 years because they believe the younger sires are more fertile and less dangerous to handle than older sires. As a result of this practice many valuable breeding animals are destroyed before their period of usefulness is little more than commenced.

Sterility in both males and females may result from a hereditary weakness or may be caused by a lack of exercise, by improper nutritive conditions, or by unwise management. The Bureau of Dairy Industry has been experimenting on the correction of sterility in females, when there was no evidence of pathological conditions, by feeding sprouted oats. About 15 animals that had not conceived from a number of services did so after receiving sprouted oats for periods averaging six weeks. An experiment is now under way to determine the effect of exercise in correcting a lack of tone in the uteri of a number of cows. Investigations show that both exercise and sprouted oats have a marked effect on the number, activity, and life of the sperm cells.

Bottle Breakage in Milk Plants

One of the problems confronting dairymen and milk dealers is how to reduce the loss of milk bottles. The annual cost of replacing bottles that are lost or broken amounts to about $30,000,000. Of this amount, over $12,000,000 results from breakage in the milk plants where milk is bottled. Investigations in milk-plant management include a study of this problem. Surveys are made at milk plants during their operation. Glass broken at various points in the plants is collected and weighed at the end of each day's run, and notes are taken on the types and arrangement of machinery, distances that bottles are moved, and means of conveying bottles from one place to another within the plant. These studies show not only the point at which the greatest breakage occurs but the character and cause of the breakage.

RESEARCH IN ENTOMOLOGY

Studies of the western pine beetle have disclosed facts that should have a wide application in timber-sale regulation, logging practice, and the management of forests where the prevention of bark-beetle losses is to be considered. Preliminary results indicate that, all other things being equal, fast-growing trees offer the greatest resistance to the insect. Very fast growth, thick bark, and large, heavy crowns are evident indications of resistant trees. It is believed that the information on the life history of the insects, the characteristics of the trees selected for attack, and the reaction of the tree during and after attack, will be of great value in obviating and correcting losses from the western pine beetle, at present the outstanding enemy of forest trees in the Northwest.

In the Kaibab National Forest, where there has been for some time an epidemic of the Black Hills beetle, investigation rendered it possible to predict a decided decline in the epidemic on this area, thus saving important expenditures in further control operations. An extremely dry summer with prevailing southwest winds appeared to lower the moisture content of the trees to an extent that the beetles and their larvae were unable to survive in the bark of the trees.

The so-called screw worm which causes losses to cattle, sheep, and goat raisers of the Southwest is coming more and more under control. Following information developed by department workers

in cooperation with State officials, many of the progressive ranchmen have now adopted the practice of burning all carcasses of animals as soon as they are found. Where this work is carried out systematically over a considerable area, the screw-worm hazard has been greatly reduced. In addition, the general use of fly traps has proved highly advantageous and is believed to be susceptible of much further development after additional studies have been made.

Japanese Beetle Campaign

While the Japanese beetle continues gradually to extend its area of distribution, increasing progress is being made in the development of methods of control. The repellant effect on the beetles of ordinary arsenicals, such as arsenate of lead when sprayed on the foliage, has been overcome by disguising the poison with a coating of lead-oleate soap. By the use of this material, fruit growers and others are now able to protect their crops from the horde of beetles present in the worst-infested territory during July and August. Successful treatments for the grubs in the soil have also been perfected and are in extensive commercial use.

An odorous material known as geraniol has proven quite attractive to the Japanese beetle, concentrating the insects in large numbers in a relatively small area, where they may be killed by contact sprays, such as pyrethrum-soap solution. This attractant is also proving effective in luring the beetles into traps from which they can not escape, the widespread use of which must greatly reduce the pest. Parasite introduction and liberation has been prosecuted with all possible vigor and shipments of material are being received continuously from Japan, China, and India. Seventeen species of these parasites have thus far been received, several of which have become established in the New Jersey-Pennsylvania area.

The cotton-growing season of 1926 witnessed a widespread outbreak of the cotton flea hopper, concerned, it is believed, in the distribution of a serious disorder of the cotton plant, which prevents the setting of fruit until the normal period of fruiting is well advanced. While weather conditions permitted the cotton plants in many areas partially to recover from the attack, and so make a late crop, in other regions a heavy loss was attributable only to this and related insects; thus in Madison Parish, La., the cotton yield was reduced by the insect approximately one-half as compared with the preceding year. Fairly satisfactory control was secured in many instances by dusting the plants with sulphur, the effectiveness of the treatment depending upon the occurrence of bright, warm days following applications.

Spray-Residue Problem

Progress continues in the investigations relating to the spray-residue problem. Because of the objectionable character of lead-arsenate residues special studies are under way to develop, if possible, for orchard spraying, poisons other than arsenate of lead. These studies include orchard tests of such materials as the arsenates of lime, iron, aluminum, zinc, barium, copper, titanium, magnesium, and manganese. Several fluosilicates, as barium and sodium, are also

under experiment. A special laboratory has been inaugurated to develop new and unobjectionable insecticides which can be used in place of arsenicals in spraying of fruit and vegetable crops. In cooperation with the Bureau of Plant Industry tests of various methods of washing the fruit in weak solutions of chemicals to remove the spray residue are under way and give great promise of successful commercial application; in fact, washing machines will be utilized largely in the marketing of the 1927 apple and pear crops in the Pacific Northwest.

CORN-BORER SITUATION

The corn-borer situation in the Lake Erie region had become alarming by the end of the growing season of 1926. Surveys during that summer indicated a degree of spread and of infestation in the States bordering Lake Erie far exceeding anything yet noted. The insect was found in the northeastern corner of Indiana and in the entire southeastern one-third of Michigan. There also had been extensive dispersion in Ohio, Pennsylvania, and New York. These circumstances indicated that if decisive steps were not taken immediately to repress the pest the great Corn Belt would soon be invaded. This situation was occasion for the voluntary organization of a committee of corn growers, agriculturists, and business men, who decided that in order to cope with the existing emergency the sum of $10,000,000 in the form of a Federal appropriation would be required.

After consideration by the President, the department, and the Bureau of the Budget this fund was provided by Congress, and Federal and State officials and others worked out a plan of corn-borer control involving the thorough clean-up of cornstalks and of all corn débris in all cornfields, for which the farmers would be reimbursed not to exceed $2 per acre for such work as was additional to that which was normal and usual in ordinary farm operations. Despite serious interruptions due to a late spring, the clean-up campaign was carried out with the destruction, according to careful estimates, of 95 per cent of the borers throughout the treated area of some 2,500,000 acres.

A census of the corn-borer population, as determined by actual count in the field during the months of August and September, 1927, in Michigan, Ohio, New York, and Pennsylvania, shows that there is now an average of 13 borers per 100 stalks in the campaign area as compared with an average of 8 borers per 100 stalks last year. In 1925 the borer population in this area was 2 borers per 100 stalks. Although this makes an increase of 50 per cent in borer population this year, it compares favorably with the increase of 400 per cent in borer population registered in 1926 when there was no control campaign. Had there been no campaign this spring, judging by the increase in 1926, there might now be about 32 instead of 13 borers per 100 stalks. The corn borer continues to spread northward, westward, and southward, as indicated by scouting, which is still going on.

At a meeting of the organization of corn growers, agriculturists, and business men, held in Detroit, Mich., September 23, 1927, the organization expressed hearty approval of the control campaign.

Boll Weevil

Continuation of general drought conditions in the Cotton Belt in 1926 reduced damage by the cotton-boll weevil during that year. However, large amounts of poison were used on cotton, primarily for the leaf worm, which covered much of the territory west of the Mississippi River, with lighter injury in parts of Mississippi and Alabama. While this poison helped to destroy the weevils in the areas treated, the absence of rains during the later months of the season was probably more important in effecting a large degree of natural control.

As a result the insect entered hibernation in greatly reduced numbers in most of the Cotton Belt. Owing, however, to the fairly mild character of the winter of 1926–27, the percentage of weevil emergence in the spring was higher than for some years. The fairly abundant hold-over of weevils, coupled with climatic conditions favorable to the insect during the succeeding months, resulted in boll-weevil damage to cotton during 1927 considerably more extensive than had been experienced for several years.

EXCLUSION OF PLANT PESTS

The exclusion of foreign pests injurious to agriculture (of which there are many which fortunately have not become established in the United States) continues to be one of the vital problems of the department. To accomplish this end, 20 foreign quarantines and several regulatory orders are now enforced, restricting, controlling, and safeguarding (by inspection, and, where necessary, disinfection) plants and plant products at ports of entry. Plant quarantine inspectors are stationed at all of the more important ports of entry; and during the year, a number of major pests have been intercepted in plants and plant products arriving as commercial shipments, ships' stores, and passengers' baggage, and in foreign parcel post. Likewise, all railway cars returning from Mexico have been inspected for cottonseed which may be the means of introducing the pink bollworm into noninfested sections of this country. As an additional precaution, all cars representing risk were fumigated in Federal car-fumigation houses.

Information gathered as a result of the inspection of plants and plant products at the port of entry frequently indicates the necessity for a more complete knowledge of the pest risks which accompany plants and plant products, if these products are to continue to enter under permit. This knowledge can be secured only by field examinations conducted by qualified specialists during the growing period. The department recently conducted such a field examination of Argentine fruits (particularly grapes) for the purpose of determining whether these fruits are subject to attack by injurious pests, including fruit flies. As a result of this survey, it has been determined that grapes and certain other deciduous fruits grown in the Temperate Zone of Argentina may continue to enter, upon inspection, at northern ports.

Protection of Uninfested Areas

Growers of agricultural products are finding introduced plant pests a serious obstacle to profitable agriculture. Many such insects and plant diseases entered the United States early in its history and have become established throughout the country. Others have come in during the last generation, and the spread of those having a local distribution is in a number of cases being distinctly retarded or completely stopped by quarantine measures administered by the department.

The plant act of 1912 has enabled the department largely to prevent the continued introduction of such agricultural enemies, and most imported products of the farms, gardens, and forests of other countries now enter the United States under restrictions which reduce such a possibility to a minimum.

The most recent outbreak of an introduced insect and one which offers a real chance of total eradication, is that of the Mexican fruit worm in the lower Rio Grande Valley of Texas. This insect is a native of southern Mexico, where it has been known to exist for many years attacking a variety of fruits, especially grapefruit, oranges, mangoes, peaches, and guavas. The danger to American fruit production from its presence in Mexico has been recognized for 30 years or more, and since the passage of the plant act a quarantine has been in effect prohibiting the entry of all known host fruits from Mexico.

Eradication by Starvation

An attempt to eradicate the pest by starvation is now in progress and is receiving the hearty support of the residents of the infested district. A preliminary step, in advance of having funds available for this emergency, has been the adoption of quarantine restrictions under which fruit from State inspected and certified orchards may be shipped interstate on condition that the eradication measures are meticulously followed throughout the entire infested area. A most hopeful feature of the situation is a natural barrier zone in the form of an arid region surrounding the fruit-growing district.

The maintenance of a similar though more artificial barrier zone for preventing gipsy-moth spread in the New England States has been successful in stopping the progress of that infestation. In fact the apparent local eradication of the moths from a number of border townships has enabled the department to release them from quarantine and thereby increase the width of the barrier zone area.

The extent of the department's activities in retarding the introduction and spread of plant pests is indicated by the fact that it is now administering 11 quarantines affecting interstate shipments, 8 restricting the movement of articles between the continent and the Territories of Hawaii and Porto Rico, and 21 governing plant and plant product importations from foreign lands. Two domestic quarantines cover every State of the country, and each of four others relate to six or more States. Specific pests of cotton, corn, flowers, vegetables, tropical fruits, deciduous fruits, forest trees, and ornamental nursery stock are included among the infestations made the subject of domestic quarantine regulations, and the foreign quarantines cover an equally wide range.

Effectiveness of Control Measures

The final effectiveness of quarantine action relating to localized infestations within the United States depends on the nature of the pest and its method of distribution. Diseases with wind-borne spores (such as the white-pine blister rust) and active, rapidly flying insects (such as the Japanese beetle) are spreading locally in spite of stringent restrictions on the movement of infested products. On the other hand, the dissemination of soil-borne diseases (such as the potato wart) and comparatively sedentary insects (such as the gypsy moth and the date scale) is completely prevented by efficient quarantine administration.

In the former class regulatory measures are being directed primarily toward preventing the establishment of isolated outbreaks which would result from the carriage of pests for long distances in commerce. In this particular the European corn borer, cotton pink bollworm, Japanese beetle, and blister rust, quarantine measures have been markedly successful. The separate areas in which there exist infestations of the pests named in most cases represent separate introductions from foreign countries prior to the American legislation on the subject.

The court decision and subsequent Federal legislation of 1926, outlined in the last report, closed the door to State quarantine action on infestations covered by Federal regulations and have therefore necessitated a close examination of each quarantine problem to determine whether it can best be handled by the States or by the Federal department. The recent extension of the Federal white-pine blister rust quarantine to the entire United States, replacing a multiplicity of diverse State quarantines, was a direct result of this situation. Certain problems, of which citrus canker, alfalfa weevil, and potato wart are examples, are at the present time being solved more effectively by State quarantine action than would be possible under Federal regulations without excessive expenditures, and are therefore left with the States.

CHEMISTRY RESEARCH

In efforts made by the Bureau of Chemistry to discover some method for utilizing the short-fiber cellulose present in farm wastes, a series of experiments on peanut hulls produced a cellulose pulp which seems to offer interesting possibilities as a raw material for rayon. Straw, stalks, hulls, and other farm materials are being studied for the purpose of discovering methods of more profitably utilizing such materials.

A method has been developed by the bureau for the recovery of paracymene, a waste by-product in the manufacture of paper pulp, which has great possibilities of development as a thinner for paints, varnishes, and lacquers, and also in the preparation of an insoluble resinous compound with excellent insulating properties. Orthodichlorobenzene, a by-product in the manufacture of chlorobenzene, was shown to be an excellent cleanser for metals. The utilization of waste products and the more profitable utilization of what may be called farm by-products are real efforts of conservation.

Insecticides Developed

As a result of chemical work on insecticides conducted this year, a method for the rapid field determination of sulphur on foliage and fruit treated with sulphur preparations was devised, the composition of colloidal calcium arsenate was determined and the best method of preparing it was worked out, and the general investigation of the chemistry of calcium arsenate, which has been under way for several years, was concluded. The chemical and physical properties of 12 crystalline arsenates of calcium, several of which are new, have been reported. Calcium arsenate is the most effective agent now known for use against the cotton boll weevil.

Results of a series of experiments to find an effective synthetic nicotine substitute indicate that it may be possible to manufacture such a substance at $1 or less a pound, as against $3, the present price of a pound of nicotine. One of the greatest needs in the war upon insects is a cheap and effective contact insecticide. If our chemists can succeed in synthesizing such a compound it will afford a striking example of the value of chemical research to agriculture.

Weevils in grain are a matter of deep concern to farmers, shippers, and warehousemen. Several highly promising new fumigants have been developed from the department's laboratory fumigation tests with some 300 organic compounds, supplemented by tests in box cars, chests, and a fumigating chamber. Perhaps the most promising fumigant for use against grain weevils is a mixture of ethylene dichloride (3 volumes) and carbon tetrachloride (1 volume). This mixture is noninflammable and cheap, has a pleasant odor, and is relatively nontoxic to man.

Prior to the work done in the department to obtain satisfactory attractants and repellents for flies which infest animals, strongly odorous materials, such as pyridine, bone oil, fish oil, and nitrobenzene, were recommended as fly repellents. The department's investigations have proved that copper carbonate, an inodorous compound, is more effective in repelling flies from meat than any of the highly odorous materials tested. The effectiveness of pine-tar oil as a repellent dressing for wounds of domestic animals has been demonstrated. Large manufacturers of proprietary screw-worm fly killers and repellents are using pine-tar oils as the basis of their preparations instead of coal-tar phenols as before.

New Methods in Sugar and Sirup Production

Because of the need of diversifying the utilization of products from sugar cane, the possibility of producing unsulphured cane sirup of good quality from low-purity cane juice and of manufacturing the new cane product, cane cream, mentioned in last year's report, was investigated. A good blending sirup can be made from low-purity juices, and, when blended with low-purity refinery sirup, it gives a sirup of excellent quality. Several hundred cases of cane cream were manufactured and distributed commercially for the purpose of learning the reaction of the consuming public toward this new cane product. The origination of new products affords greater flexibility in meeting market conditions, which is of prime importance to the cane-sugar industry of continental United States. These investigations illustrate the manner in which chemical technology

can be applied for the purpose of facilitating the marketing of agricultural products to the benefit of the producer.

Tests of Sugar-Bearing Juices

In preparing cane and beet juices for recovery of sugar by crystallization, nonsugar substances in the colloidal state interfere with the process. The removal of these materials to the greatest extent possible is desirable. By the use of an improved method developed in the Bureau of Chemistry it became possible this year for the first time to estimate rapidly the quantity of colloids in sugar-bearing juices. This method, termed the "dye test," together with ultrafiltration, has given important information relating to the effect of cultural conditions and deterioration on the quality of the plant juices, information of special value in the study of clarification problems. The dye value has been found to be an index of the refining quality of raw sugar. Realizing the value of such a test, both refiners and manufacturers of raw sugar are adopting it as a measure of controlling or improving their factory operations.

Lignin

Investigations initiated by the bureau in 1920 upon the utilization of corncobs and other agricultural wastes for the production of the chemical furfural are now being applied commercially. An important constituent of cellular products such as corncobs, cornstalks, straw, etc., which is now almost entirely wasted, is lignin, which makes up from 20 to 30 per cent of the dry material. The bureau has succeeded in converting lignin into varnishes, dyestuffs, and various aromatic chemicals which give great promise of commercial utilization. Lignin may be called the greatest of all unutilized agricultural wastes, and it occupies with respect to industrial possibilities the same position that was held by coal tar a century ago. The bureau has published one article upon lignin from corncobs (Jour. Amer. Chem. Soc. 49 : 2037), and other contributions upon the subject are in course of preparation.

Gossypol

A research fellowship, established by the Interstate Cottonseed Crushers Association, is devoted to an investigation which is being conducted in the laboratories of the Bureau of Chemistry and Soils upon gossypol—a poisonous phenolic constituent of cottonseed. The presence of gossypol in cottonseed meal has resulted occasionally in the death of farm animals that have eaten too large a quantity of this substance. The results thus far obtained under this fellowship have thrown new light upon the chemical constitution of gossypol. When this phase of the problem has been solved experiments will be made upon the application of the information to the detoxification of cottonseed products.

Enforcement of the Food and Drugs Act

The Federal food and drugs act, designed to prevent the sale of adulterated or falsely labeled foods, drugs, and feeding stuffs, is a

benefit to consumers and producers alike. Through its enforcement the consumer may feel confident that the products he buys are what they are represented to be on the labels and the producer need fear no competition with low-grade goods masquerading as high-quality goods. Cooperation with the various industries in an effort to keep their products in conformity with the law and action against producers found guilty of deliberately adulterating or misbranding their goods were continued during the fiscal year just ended.

Particular attention to citrus fruit was necessary this year because of the cold wave which swept over Florida in January, frosting much of the fruit then ripe or ripening on the trees. To protect the industry against the stigma bound to result from the sale of large quantities of juiceless oranges, as well as to safeguard the interests of the consuming public, the department issued announcements warning shippers of the worthlessness of frozen fruit and reminding them that regulatory action would be taken against any shipments found to be dried beyond a specified tolerance. Some unscrupulous shippers disregarded these warnings and attempted to place unfit fruit on the market. Legal action brought in such cases resulted in the seizure of 142 shipments.

Drugs

An outstanding phase of the work under the food and drugs act on drug products was the completion of an investigation begun several years ago of all pharmaceutical preparations on United States markets. During the year 45 per cent of all samples of such products collected in the East were either grossly deficient or contained an excess of the active medicinal ingredient. Such variations may be due to imperfect mixing or to the natural deterioration of some of the ingredients, such as nitroglycerin. Although it is difficult to prepare uniform pharmaceutical preparations, adequate control measures in manufacture would go a long way in preventing wide discrepancies between the label declaration and the condition of the product. The importance of being able to rely on the potency of these preparations is obvious.

So-called acidophilus and Bulgaricus preparations have flooded the market during the last two years. An examination of the output of 21 representative manufacturers led to the conclusion that most of these products are useless. Ninety per cent of the samples examined contained few or no active organisms and those that did show them contained the organisms in such small quantities that it would be necessary to consume enormous quantities of the preparations to derive any benefit. Warnings of the uselessness of these products and of the Government's intention to free the market of misbranded, deteriorated, or contaminated pharmaceuticals have been sent out to the trade.

Insecticides and Fungicides

Every year the department's inspectors operating in connection with the enforcement of the insecticide act of 1910, cover the field of commercial insecticides and fungicides fairly thoroughly. The older insecticides and fungicides become standardized and are recom-

mended by the manufacturers to be used in the manner and for the purposes for which they are effective. They are therefore easier to supervise. Each year, however, many new products are put on the market, oftentimes by manufacturers who are ignorant both of entomology or plant pathology and of the law. Some of them are worthless, some are valuable products.

In either case they are likely to be labeled with false and misleading statements and to lack the "active and inert statement" required by the insecticide act. Samples of this type require constant supervision and thorough analytical control. Some of the newly developed insecticides and fungicides show signs of a general usefulness. Among these may be cited the fluorides and fluosilicates, pyrethrum extracts, organic mercurials and copper carbonate. Materials of this type are studied both with regard to their physical form and the conditions under which they must be used so that their labels may be intelligently criticized.

Some time ago products consisting essentially of salt, sulphur, and lime or charcoal began to appear on the market. They were recommended for internal administration to animals to combat flies with which the animals are infested. These products were tested and found to be worthless. As a result a campaign against them was undertaken and they now seem to have disappeared from the market.

Calcium Arsenate Studied

From time to time it is necessary to undertake the basic study of the chemical nature of an insecticide for the better understanding of the composition of commercial preparations containing it. Calcium arsenate, in particular, is a rather complex material. An investigation of all the compounds of lime and arsenic acid which has been under way for several years has been completed. Twelve definite compounds have been prepared in pure form and their physical and chemical properties have been studied in detail. A complete account of this work will be published.

The estimation of residues left upon fruit and foliage after spraying is often important, for reasons of health in the case of arsenicals, and for the estimation of adhesiveness and lasting qualities in other cases. Quick field methods are desirable and such a method has been developed for detecting and estimating the quantity of sulphur left after spraying with lime-sulphur solutions or other sulphide preparations. This method is being used by the inspectors of the Office of Blister Rust Control for determining whether currant and gooseberry bushes have been dipped in lime-sulphur as required by law.

THE SOIL SURVEY

The soil survey covered a total area, during the fiscal year 1926–27, of 23,199 square miles. Work in soil mapping was carried on in 69 survey projects, one or more projects being located in each of 28 States. All projects were surveyed in cooperation with some State organization.

The work of the soil survey is done primarily for the purpose of accumulating data on the basis of which the fundamental principles of soil genesis development and use may be formulated. In doing

this the study of the soil in its natural place is indispensable. Intensive studies not possible by field methods or equipment are necessary also, however, if the whole story is to be told. This work must be done in the laboratory and must be performed on material brought to the laboratories from the field. The collection of material for this purpose must be performed in the light of the knowledge obtained by field investigation. Accordingly, much time and attention have been devoted to the methods of collecting samples.

Soil-Erosion Studies

Our soil specialists find that here, as in other parts of the world, failure to hold the absorptive surface soil of fields and pastures against the denudation of erosion has contributed to a much more rapid removal of the water that falls upon these eroded lands. The mellow topsoil that is gone was far more retentive of moisture than the comparatively impervious subsoil that sheet erosion has left behind. These specialists believe that this wastage of the soil has as much to do with the constantly increasing floods as all other factors combined. Many streams navigable a generation ago are now clogged with soil débris.

Failure to build terraces on sloping fields generally and to plant grass and trees on the steeper lands highly susceptible to rain wash accounts for much of the excess of water now sweeping down the Mississippi. If this kind of soil wastage on an enormous scale is not stopped there is little likelihood that floods will be controlled. Practically nothing is being done about this phase of flood prevention. There are no hillside terraces north of the Arkansas River. The entire topsoil is gone from hundreds of thousands of acres in western Virginia, western Pennsylvania, eastern Kentucky, and southeastern Ohio. From these lands rain water courses much faster to the Mississippi than formerly. Terraces and grass wood lots, forests, and soil-binding and soil-building crops will vastly improve the flood situation. Not only will they slow up the run-off of water, but they will save the most valuable part of the soil, and will reduce the clogging of streams, which cuts down their carrying capacity and adds to the flood danger.

Congress of Soil Science

From the agricultural viewpoint one of the outstanding scientific events of the year was the assembling of the First International Congress of Soil Science at Washington from June 13 to 22, 1927. Official approval of this congress by the Federal Government was contained in a joint resolution enacted April 3, 1926, which empowered the President to extend formal invitations to foreign governments to be represented by delegates. The International Society of Soil Science, headed by J. G. Lipman, of New Jersey, sponsored the congress. D. J. Hissink, of Holland, served as general secretary.

FERTILIZER AND FIXED-NITROGEN INVESTIGATIONS

The year witnessed progress in the development of a more consistent and comprehensive program of research in fertilizer technology, on the one extreme embracing the raw materials involved

and on the other their actual application under field conditions. The investigations include all the chemical elements of recognized fertilizer value, but of necessity are concerned principally with nitrogen, phosphorus, and potassium. Work done in the American nitrogen-fixation industry promises at an early date increased supplies of agricultural nitrogen from this new source. The department's laboratories served the industry by supplying fundamental data and engineering details.

The immediate product of nitrogen fixation being ammonia, the efficient elaboration and conversion of that gas into a diversity of nitrogen compounds for agricultural use—such as nitrates, urea, and ammonium phosphate—have been vigorously prosecuted. This has resulted in the development of new compounds and mixtures whose adaptability to fertilizer use has been tested through a study of their physical properties, and their behavior on mixing and storing. Their adaptation to use in seed drills has also been tested. At the same time the search for new or enlarged supplies of organic nitrogenous substances among agricultural or trade wastes has been fruitful.

The year recorded further progress in the development of chemical processes of recovering agricultural potash from the potash-bearing minerals and trade wastes, of which there are liberal supplies in this country favorably situated with respect to agricultural areas. By-products to share the manufacturing costs of the potash are an essential of modern potash recovery. The department's investigations therefore consider primarily the useful products obtainable concurrently with potash from these raw materials. American agriculture is still dependent on Europe for 75 per cent of its potash requirements. A serious deterrent to the use of potash is the cost of its transportation which can be overcome only by the development of American potash industries situated closer to the farms.

AGRICULTURAL EXPERIMENT STATIONS

Federal acts appropriating money for the support of the agricultural experiment stations place upon the department the responsibility of administering these funds. The relationships thus established have tended to develop a community of interest and spirit of cooperation which have greatly strengthened the effort to promote agricultural research and extend its benefits.

The income of the State experiment stations for the current year from the Hatch, Adams, and Purnell funds amounts to $3,360,000 and will increase under the terms of the Purnell Act $480,000 annually until it reaches a total of $4,320,000 for the fiscal year 1930 and thereafter.

The increasing Federal support of the stations provided by the Purnell Act is steadily expanding their research program, making possible broader and more effective cooperation with the department. Such cooperation has already resulted in a marked advancement of study of some of the larger national problems affecting agriculture, especially in the economic field, but also in the fields of food production and its use in the home and home betterment.

Joint committees of department and station representatives are functioning effectively in promoting cooperative study on a wide scale of marketing and distribution of farm products, of vitamin

content of foods and their relation to human nutrition, of rural home management, rural social organizations and agencies, and of factors affecting the quality and palatability of meat.

The total income of the stations from all sources is now close to $12,500,000, and their program of investigation is as broad as the field of agriculture itself. The amount of funds involved and the conditions under which they are granted, the wide interests to be served, and the exacting character of effective research place a heavy burden of responsibility on those who administer these funds, in order that a high standard of productive research, measuring up to the needs and expectations of the public and justifying the generous support of Congress and the States, may be maintained.

INSULAR EXPERIMENT STATIONS

The agricultural experiment stations maintained by the department in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, established by specific authority of Congress, are trying to develop for each region types of agriculture adapted to the needs of the people. In Alaska the problem has been that of establishing an agriculture suited to the seasonal variations in so large a region. In Hawaii and Porto Rico diversification of agriculture is the main problem. The large industries of sugar production and pineapples are well cared for by stations supported by the industries, and in Porto Rico the sugar industry is able to solve most of its problems. As a consequence the stations are doing little with these major crops and are devoting their attention to minor crops that will not compete with the larger ones but supplement them and furnish outlets for capital and industry that are not employed in the larger plantation operations. This diversification it is believed will tend to build up a better citizenship. In Guam the station is endeavoring to improve agriculture and agricultural practices that were in an unsatisfactory state. In the Virgin Islands changed economic conditions called for a greater agricultural development, and the station is trying to develop new lines of production.

Every station has made progress in the field which it has tried to cover, and the way to successful enterprise has been pointed out to many to whom the established industries were closed. In all their work research has been kept in the foreground, and the results of the experiments have been given application in other regions somewhat similarly situated.

In providing for the insular experiment stations Congress established a policy separate from that governing its relations with the stations in the several States—that is, the centralized control of the institutions. It was believed the Federal acts making appropriations to the States were not applicable in the various Territories and possessions. Greater latitude was given to the use of the funds, as it was recognized that none of the regions could profitably and economically carry out the requirements of the laws under which grants are made to the States.

WILD-LIFE EXPERIMENT STATIONS

Of vital concern to the continuance of the fur trade, which is one of the oldest industries of the country, is the perpetuation of

the source of supply of raw materials. So popular have fur garments become that the demand for pelts is ever increasing. As a result overtrapping has been stimulated until fur-bearing animals are rapidly diminishing. Reports to the department indicate that the catch of fur in the wild has greatly fallen off in the past two years. Seeing the inevitable approach of this condition far-sighted men began several years ago to raise fur animals in captivity to supplement the natural supply, and fur farming is now a flourishing industry.

For several years appropriations have been made available for the department to make investigations, experiments, and demonstrations in connection with the raising of fur-bearing animals and to study their geographic distribution and relations. To provide great quantities of attractive furs at reasonable prices, the dwindling stocks have been further supplemented in recent years by the production of suitable breeds of rabbits for fur, the meat being utilized for food, particularly in the West.

That it may study the problems confronting producers of fur of all classes and advise them in the early stages of their undertakings, the department maintains a fur-animal experiment station in the Adirondack region, N. Y., and at the close of the year it had completed arrangements for establishing a rabbit experiment station in southern California.

Two other wild-life experiment stations are maintained by the department, one near Fairbanks, Alaska, for studying problems in reindeer production, including herd improvement and range management, and the other in Colorado for developing efficient methods of controlling injurious rodents and predatory animals, from both of which practical results are being obtained. In addition, studies of experimental areas and of animals under selected environmental conditions are being made to furnish a basis for intelligently directed control efforts.

Animal Pests of Crops and Stock

Predatory wild animals, particularly wolves, mountain lions, bobcats, coyotes, and lynxes, take heavy toll of sheep, young calves, poultry, and other livestock, and make serious inroads on wild stocks of game, including deer, elk, and their young, as well as on ground-nesting game birds. In control campaigns directed by the department against predatory animals in the last fiscal year, the skins or scalps of 47 big gray wolves, 154 red wolves, 37,887 coyotes, 246 mountain lions, 3,677 bobcats, 41 Canada lynxes, and 186 predatory bears were taken, representing a saving of $5,500,000 to livestock and wild game. All of this was accomplished in cooperation with 11 range States, which through their legislative bodies, counties, and stock associations, added approximately $370,000 for the various control campaigns to the $274,400 available in departmental funds.

The department supervised control of injurious rodents in 14 States west of the Mississippi River and in 11 of the Eastern States. Prairie dogs, ground squirrels, pocket gophers, field mice, rabbits, woodchucks, house mice, porcupines, and rats are the cause of much damage to growing and stored crops in farming districts as well as of much concern on grazing lands on national forests and other public domain. The States contributed funds for the rodent-control

campaigns to the extent of $641,600, counties, stock associations, and individual farmers and ranchmen cooperating. In conjunction with $165,600 from the department's appropriations, this resulted in the treatment of 14,991,968 acres of infested Federal, State, and private lands. The savings thus effected in crop and range grasses for the year are conservatively estimated at $5,700,000. The funds used in control campaigns against both predatory animals and injurious rodents, including investigations of eradication methods, totaled more than $1,000,000 from cooperators and slightly less than half a million from funds of the department, the grand total being $1,473,294.

The Game-Bird Supply

With increasing population and its correlated activities, the felling of forests, the draining of marshes, and the numberless developments that accompany the more intensive occupation of the land, it is inevitable that there should be some reduction of our wild life. This is especially evident in the case of our game birds, and notably during the past 25 years. The department has endeavored to check this decrease as far as possible by education regarding the value of our wild life and by the encouragement of salutary legislation. No game birds are more important that the waterfowl. State, Federal, and international protection have helped stem the tide of destruction, but the real extent of our wild-fowl resources is in doubt. It is now planned, however, by a nation-wide series of simultaneous observations to be made by trained volunteer cooperators, to gain a clearer view of conditions and enable the department to meet intelligently problems of game protection.

Legal Protection of Birds

The enforcement of the migratory-bird treaty act, which is under the direction of the department, is designed to carry out the terms of the treaty between the United States and Great Britain by which the two countries undertake to provide protection for the song and insectivorous birds, the waterfowl, and the shore birds that migrate between the United States and Canada. The activities of Federal game wardens have improved greatly the conditions affecting the maintenance of these valuable creatures. The destructive practice of the spring shooting of migratory waterfowl has been stopped generally, the sale of migratory game birds has been prohibited, and violations by market gunners have been reduced. The migratory song and insectivorous birds, so valuable to agriculture, are now given the protection of a closed season under the provisions of this act. The Lacey Act, which is also administered by the department, prohibits the interstate shipment of wild animals in violation of State laws, and the cooperation extended in the enforcement of this act has resulted in an increased revenue to the States through the institution of prosecutions based on evidence furnished by United States game wardens. The effect has been to restrict greatly illegal traffic in furs and in the carcasses of wild animals.

Perpetuation of Elk Herds

Through its administration of the winter elk refuge, near Jackson, Wyo., and of the national forests, which, aside from the Yellow-

stone National Park, include the principal remaining elk ranges, the department has been keenly interested in the so-called "elk problem," centered largely in the State mentioned. The elk of this region comprise the last of the big-game herds that formerly ranged nearly across the continent. Although summer forage for elk is ample, the winter range has become greatly restricted through settlement of the country, and in unusually severe winter seasons the feeding conditions for the elk are deplorable and many of the animals die of starvation.

To consider the elk problem and provide remedies for present conditions, an elk commission, members of which were designated by the chairman of the President's Committee on Outdoor Recreation from representatives of Federal and State Governments and of important conservation organizations, met in Washington early in March.

Elk Commission's Findings

The commission's recommendations, recently published, were that provision should be made for an optimum number of 20,000 elk in the so-called Jackson Hole herd, to which special consideration was given at that time, the needs of other elk herds to be considered later; that certain additional lands be acquired for winter-refuge purposes along Jackson Valley; and that as a basis for future administration of the herds studies be made of the life history of the elk. In accordance with this last recommendation the department has begun an intensive study of grazing and feeding conditions for the elk and of their parasites and diseases by cooperation of several of its bureaus and other interested agencies.

Upper Mississippi Wild-Life Refuge

More than 60,000 acres, from all sources, have been acquired for the Upper Mississippi River Wild-Life and Fish Refuge, for which Congress has authorized an appropriation of $1,500,000. The people of the surrounding region and conservationists generally throughout the country have supported enthusiastically the establishment of this refuge. Eventually the refuge should include about 165,000 acres of lands subject to overflow along the Mississippi between Wabasha, Minn., and Rock Island, Ill. The limitation of $5 an acre as the average price that may be paid for land, slowed down the acquisition work considerably during the year. Most of the land desired commands a higher price, and under the present limitation it is not likely that more than 10,000 acres can be added during the coming year. The funds provided probably are ample for the purpose, but it is desirable to increase the existing average limit per acre, for prolonged efforts to purchase at the present figure will increase the overhead cost materially.

EXTENSION WORK

The cooperative extension staff at the end of the fiscal year numbered 5,055 persons, an increase of 90 during the year. Of this number, 3,603 were employed in the counties, 2,263 being in agricultural work, 910 in home demonstration work, 153 in boys' and girls' club work, and 277 in extension work with negroes. Subject-matter specialists located at the State agricultural colleges numbered 977, of whom 774 were full-time and 203 part-time workers. Administrative

officers, supervisors, and assistant supervisors numbered 475. These figures show an increase of 90 county workers and 5 administrative and supervisory workers, with a decrease of 5 subject-matter specialists.

Total funds available for cooperative extension work during the year amounted to $20,148,800, an increase of about $350,000 over the previous year. Of this amount, 36.3 per cent was contributed by the Federal Government, 28.4 per cent from State appropriations, and 35.3 per cent from county appropriations and contributions of local organizations. Approximately 95 per cent of all funds used for cooperative extension work came from public sources. The allotment for extension agents in the counties was $12,629,042, or 62.7 per cent of the total; administrative expenses were $1,134,080, or 5.6 per cent, and supervision of county extension workers cost $2,188,512, or 10.9 per cent of all extension funds. The cost of employment and maintenance of subject-matter specialists was $3,831,492, or 19 per cent of the total. The remaining 1.8 per cent was expended for activities of the Federal Extension Service in Washington.

Improvement in Farm Practices

Reports of extension agents showed that in more than 4,100,000 instances improved practices were adopted on the farms and in the farm homes in 1926, an increase of more than 100,000 over the previous year. The principal projects in which improved practices were adopted were the growing of cereals, legumes, forage, and horticultural crops, dairying, animal husbandry, rural engineering, agricultural economics, foods, nutrition, house furnishing, home health, and sanitation. Demonstrations, meetings, tours, campaigns, and press articles were among the effective means of bringing desirable practices to the attention of the rural public. More than 222,000 volunteer local leaders gave important assistance to paid extension workers.

Enrollment in boys' and girls' 4–H clubs was 586,156, of whom 62.8 per cent completed the projects in which they were engaged. This was an increase of 21,000 in total enrollment and of 39,000 in the number completing their assigned work. Nearly 50,000 volunteer local leaders assisted the paid extension workers in the training of boys and girls. The club members were enrolled in 41,234 local

Emergency Activities

Extension workers gave aid in meeting serious emergency situations which arose during the year in different sections of the country. The sharp fall in cotton prices in 1926, due to the very large crop, led to the adoption of an extension program to lessen the financial distress of cotton growers. Extension workers urged farmers to grow cash crops other than cotton, to increase their acreage of feed crops, and to grow at home more of the food consumed by the family. They advised increases in dairying and poultry raising, both to provide additional dairy and poultry products for home use and to supplement cash incomes. Corn, annual legumes, potatoes, and sweet potatoes were grown on increased acreages.

The damage to farm property in southern Florida by the hurricane of September 18, 1926, made it necessary for farmers to find sources of income from which quick returns could be obtained. Ex-

tension agents aided in relief work and in helping farmers to obtain loans for the purchase of seeds and supplies.

Motion Pictures

Eighteen new motion pictures were completed during the year, the more important being 3 reels on the corn borer and its control, a 2-reel picture on cooperative marketing, and 6 reels on road building in the national parks. A 2-reel picture on women's vacation camps, and 3 reels illustrating farmers' week meetings at western colleges portrayed some of the newer developments in extension work. The department now has 222 different motion pictures, of which 1,792 copies are available for circulation.

FEDERAL-AID ROAD CONSTRUCTION

By completing in the last fiscal year the construction of 8,306.9 miles of the Federal-aid highway system not previously improved with Federal assistance, the total thus improved was increased to 64,209.7 miles, or approximately a third of the total of 185,772 miles of important interstate roads in the system. As more than an equal mileage has been improved by the States without Federal aid it is probable that about three-quarters of the system is now initially improved.

In addition to the new construction above reported, secondary stages of improvement were completed during the year on 1,376 miles previously improved with Federal aid. This secondary improvement consists largely of the surfacing with gravel of roads previously graded, or the further improvement of gravel roads by surfacing with a higher type of material. This is necessary to enable the low-type highways to withstand the constantly growing traffic, which, following the upward curve of motor-vehicle registration, has doubled since 1921, the year in which the Federal-aid highway system was designated.

The Federal-aid roads now completed are classified according to type of surface as follows:

Type of surface	Miles
Graded and drained	10,798.9
Sand-clay	5,721.7
Gravel	25,547.6
Waterbound macadam	1,309.9
Bituminous macadam	3,680.0
Bituminous concrete	1,818.9
Portland cement concrete	14,391.3
Brick	773.8
Bridges	167.6
Total	64,209.7

In addition to these completed roads, 10,103 miles were under construction at the end of the fiscal year, and 2,395.6 miles had been approved for construction. These projects with others to be initiated later will constitute the program of the coming year.

The Federal-aid highway system, in which all of these roads are included, is limited in each State to 7 per cent of the total mileage of highways, and within this limitation includes the most important interstate and intercounty highways. The Federal appropriations which are applied to the improvement of the system are apportioned

among all the States in proportion to their area, population, and mileage of rural post roads. On this basis each State receives a part of each appropriation, which, in proportion to the mileage of the designated system, is greatest in the Middle Atlantic and New England States and least in the West and East South Central States.

Banked on the basis of the average density of highway traffic the several sections of the country are found to take practically the same order, thus indicating that the apportionment of Federal aid is highly consistent with traffic requirements.

National-Forest Highways

The improvement of national-forest highways is of particular importance in the 11 Western States and Alaska, not only for the protection and development of the forests themselves, but also to provide means of transportation across them. As practically every transcontinental road must at some point pass through one or more of these areas, it is essential that there be a close correlation between the forest-road construction and the program of Federal-aid road improvement. This has been accomplished by the establishment of a forest-road program through the cooperation of the Bureau of Public Roads, the Forest Service, and the affected States.

The more important roads from the standpoint of transforest communication are constructed under the supervision of the Bureau of Public Roads; those required mainly for the protection and administration of the forests are built and maintained by the Forest Service.

Roads of the first class constructed during the year by the Bureau of Public Roads have an aggregate length of 452.8 miles, of which 378.9 miles are in the 11 Western States and Alaska, and the remaining 73.9 miles are widely scattered in the Eastern States. Added to the mileage previously completed these roads advance the total completed to 3,498.5 miles, located by States, as follows:

Mileage of forest roads completed to June 30, 1927

Alaska	151.62
Alabama	5.00
Arizona	237.12
Arkansas	56.76
California	252.16
Colorado	265.96
Florida	64.24
Georgia	18.59
Idaho	439.58
Minnesota	34.57
Montana	343.61
Nevada	103.91
New Hampshire	3.59
New Mexico	164.17
North Carolina	36.27
Oregon	516.61
South Carolina	5.27
South Dakota	41.51
Tennessee	37.83
Utah	285.00
Virginia	11.88
Washington	188.30
Wyoming	234.90
Total	3,498.45

Distribution of Surplus War Material

The distribution of surplus war material begun by the department in 1919 was brought to practical completion during the past year. Only a small quantity of explosives now remains and this will be distributed during the coming year. The total value of the material distributed, exclusive of explosives, is estimated at $242,500,000, and practically all of it has been used by the States in furtherance of the improvement of the highways.

The material distributed, including motor trucks, tractors, road-building equipment, and tools, has been especially useful in the maintenance operations which are carried on with State forces, differing in this respect from construction which is largely conducted on a contract basis. When the war equipment was first offered, a number of the States were insufficiently equipped to carry on this essential work. In such States the material received from the Government was used to make timely repairs to highways which otherwise probably would have deteriorated for lack of the necessary maintenance equipment.

The surplus explosives have been usefully employed in road construction and, by farmers, in the clearing and drainage of agricultural land. Converted into forms suitable for agricultural purposes, various war explosives of an estimated value of $9,500,000 have been supplied at cost in carload lots to State agricultural colleges and other distributing agencies, and by these have been sold to farmers at prices considerably below the market price.

Highway Research

The highway research carried on by the Bureau of Public Roads is designed to promote economy in design and construction and to improve the service value of the highways. Of special importance in the work of the past year have been the studies of the possibility of reducing the effects of motor-truck impact by changes in the spring, wheel, and tire equipment of vehicles, and by refinements in the surface finish of roads.

THE FOREST SITUATION

The forest situation in the United States remains critical. Gradual gains in forest protection and in timber growing on privately owned land are being made, but our forest products are still obtained largely through timber mining, not through practices which insure replacement. The idle-land evil is probably extending, though at a decreasing rate. One by one industrial units operating on virgin stumpage in the Lake States and the South come to the end of their raw material, and vanish; and often the lumbering of second-growth timber is still merely a prolongation of the process of depletion.

This, however, is not a complete picture. It sets forth only the dark side, a side which needs to be frankly recognized. To assume that the country's forest problem is virtually solved and that it will work itself out shortly as a matter of industrial evolution would be a serious mistake. The situation demands a larger program of public action than has yet been entered upon. Yet there are excellent reasons for optimism.

The forest situation in the West is, on the whole, in better shape than in the East. Primarily that is because so much of the western timber is in national forests. They contain one-third of the saw timber and almost two-thirds of the forest land. Other forms of public ownership raise the total acreage so owned to 72 per cent.

For the entire country, on the other hand, 4 acres out of every 5 are privately owned. With so large a part of the western forest land in public ownership, and with the certainty that most of the present Federal and State timberlands will continue to be held as permanent public properties, the West should never have to face a problem of forest restoration as acute as that now confronting the East.

The greatest obstacle to more rapid progress in forestry in the West is the fact that altogether too much mature timber is seeking a market through manufacture. The immense volume of stumpage in private hands creates a pressure to liquidate which makes the underlying economic condition of the lumber industry in that region unstable. What is needed more than any other one thing in practically all parts of the West is relief from this pressure.

National Forest Timber Sales

The presence of the national forests, of course, makes this pressure materially less than it otherwise would be. Were the publicly owned timber of the West private property, orderly marketing would be incomparably more difficult, waste far greater, and the prospect of rational forest land use much more distant. The national forests also serve as proving grounds of practices necessary for timber growing and thus exert a powerful educational influence on the lumber industry.

It is objected, however, that selling western national-forest timber even in the present moderate quantities tends to increase market instability. In comparison with the total cut, that derived from the national forests is insignificant. Although they contain one-fourth of the standing timber in the United States they furnish but 2 per cent of the total lumber cut, and in Oregon and Washington less than 3½ per cent of the cut. Stumpage prices are not put low to attract purchase but are maintained at a fair level and subjected to competitive bids. Virtually all the timber sold goes either to meet the needs of a local public dependent upon neighboring national forest lands for their supplies, or to maintain local industries already established, or to help the economic development of regions which would be held back without offerings of national-forest stumpage, or to prevent the waste of timber through its decadence, or through failure to dispose of it when intermixed private timber is being cut. The policy of utilizing national-forest timber is conservative, and it should not augment the current tendency toward overcutting in the West.

The total cut from the national forests last year, both for lumber production and for poles, ties, mine timbers, pulp wood, piling, fencing, fuel, and like uses, was the equivalent of 1,170,000,000 board feet under sales, 88,000,000 board feet under free use, and 83,000,000 board feet under agreements for the exchange of timber for private land within the forest boundaries. At the current rate of cutting

for all these purposes some 400 years would be required to harvest the present stands of merchantable timber in the national forests.

Further Needs for Public Action

In recognition of the obstacle to the investment of private capital in timber growing which a long period of carrying charges on young forests sets up, California enacted and Oregon considered legislation designed to protect young growth from overheavy taxation. There can be no question of the need for finding more rational and equitable methods of taxing lands devoted to timber growing than the methods now prevailing in most States. Since the situation in the Northwest is a difficult one for timberland owners and for progress in forestry, the study of the tax problem inaugurated by this department under authority of the Clarke-McNary law will be extended into that region during the present fiscal year. While in the main the fundamental economic conditions created by the large supply of private timber awaiting manufacture in the Northwest, as against the absorptive capacity of present markets, will have to work themselves out, it is sound public policy to adopt any reasonable measures that will hasten the process of adjustment and increase the feasibility of private timber growing. Reforestation on a substantial scale has already been undertaken by industrial interests in several portions of the West. With the adjustments in taxation and industrial organization that are feasible, there are strong reasons for confidence that the West will make the transition from the exploitation of virgin forests to timber growing without having to pass through a stage of depletion like that which now exists in the East.

But the West contains only one-fourth of the forest land in the United States, and although it now has three-fifths of the saw timber in the entire country, even under intensive forest culture it can not permanently produce much if any more than one-fourth of the present annual drain on our forests. Further, in course of time it will itself consume most of what it grows. The East consumes three and one-half times as much lumber as the West. It has approximately five-eighths as much standing saw timber. Less than 3½ per cent of its forest land is publicly owned. What are its prospects for timber growing?

Prospects for Timber Growing

In many ways they are decidedly encouraging. Public realization of the importance of the forest problem and interest in its solution are more marked than ever before; State forestry, including the promotion of timber planting, shows rapid progress; municipal forests are being extended; there has been a substantial enlargement of organized fire protection and advancing efficiency in protection efforts; and there is taking place a gradual expansion of farm forestry and industrial forestry, and a steadily growing interest on the part of landowners in the economic possibilities of timber crops. On the other hand, private owners are still uncertain whether timber growing can be made profitable, partly because of high fire hazards and the danger of higher taxes than this form of land use can support; insufficient knowledge, both silvicultural and economic, is avail-

able for their guidance; there is lacking adequate means for acquainting private owners with the best practices that have been worked out, and with the benefits obtainable through their use; and there has been very meager development of eastern public forestry in the form of Federal and State forests, to point the way to private owners and to bring under management the considerable areas for which public ownership is distinctly required.

Forestry in the South

The progress that the Southern States have made in public provision for forestry has been unequaled in any other region during the last five years. Since 1923 six States have inaugurated forestry work, and the only one which still remains without any provision for it is Arkansas. Including Missouri in the group of Southern States 13 are now cooperating with the Federal Government in protecting their forest lands against fire. The interest of southern timberland owners in the possibilities of forest production is becoming widespread; a considerable number of them are already engaged in it. The South has great advantages for continuous timber production and likewise very great need for it as a means of maintaining industry, increasing wealth, and keeping land in use. Yet public activities to promote timber growing will have to be enlarged if the transition to wise land use for this purpose is not be regrettably delayed.

In both the Appalachians and the Ozarks the bulk of the timberland is in large private holdings, chiefly of lumber, pulp and paper, and other industrial enterprises, or of individual lumbermen. Federal land purchases to build up national forests in the Appalachians and the Ouachita and Ozark National Forests established in Arkansas by withdrawing public lands for this purpose have extended public administration to a limited part of the total area; forest protection under State leadership is steadily gaining ground; and industrial forestry is being undertaken on the holdings of a few companies. The State of Pennsylvania has purchased more than 1,100,000 acres of her mountain lands and is putting them under administration as State forests. North Carolina and Tennessee are joining in an effort to acquire and donate to the Federal Government 700,000 acres in the Great Smokies to be administered as a national park. There is every reason why many of the Southern States should have large State forests covering their more rugged portions.

"Piney Woods" Country

The "Piney woods" country of the South presents very different conditions. From eastern Maryland to eastern Texas the Coastal Plain contains a large percentage of forest land. This southern pine belt comprises more than 100,000,000 acres which will probably be put to its best use through timber growing rather than agriculture. Most of the original pine has been cut. It has contributed enormously to the economic life of the South, and the forced cessation of its lumbering will be a severe blow to the region. In spite of the inveterate southern custom of woods burning, enough second growth has sprung up and reached merchantable size to prolong

somewhat the southern pine-lumber and naval-stores industries. But only the general practice of timber growing will make them permanent on an extensive scale.

The southern pinelands, however, have another possible form of use. Grass often covers the cut-over lands with an apparently luxuriant forage crop. Stock raising is general, and the prevalence of forest fires has been due first of all to the belief that it improves the pasturage. Far too little is known regarding the best methods of livestock production in the South. There is no adequate knowledge of how far it will be practicable and advantageous to combine timber growing and grazing under improved methods, or where one or the other will constitute the more profitable use. Fires, grazing, and timber reproduction are bound together in a difficult problem of land management. And in addition the question enters as to where and to what extent the cut-over pinelands might better be devoted to agriculture than to forest use or pasturage. Thus the problem of forestry in the pine country of the South brings into view many matters that must be subjects of research. The time is ripe for rapid change, and with suitable public leadership, assistance, and education timber growing will surely work into the place in southern land use that its prospective returns justify.

Joint Program for Southern Forestry

Concretely, the States of the South and the Federal Government should share in a program jointly devised to obtain adequate protection of all forest lands against fire, to provide the research necessary to the best land use, to pass on the knowledge yielded by research to those able to profit by applying it, to locate public forests of sufficient number and extent to exercise a powerful stimulating influence on private forestry, and to devise and enact enlightened, economically sound laws with respect to forest taxation.

Pulp and Paper Industry in Alaska

A notable development of the year in national-forest administration was the initiation of two projects for the utilization of pulp timber in Alaska—by far the largest sales of Government timber that have ever been made. There are two national forests in the Territory, both on the coast. The larger and more southerly is the Tongass. It is here that the pulp-timber areas covered by the present sales are located. Together they embrace more than 8,000,000 cords of pulpwood stumpage. The Tongass has all told about 120,000,000 cords of such stumpage, and its estimated permanent growth or continuous yield of pulpwood is at least 1,000,000 cords annually. This would permit an output for all time of not less than 1,000,000 tons of newsprint paper a year, or one-fourth the present consumption of the entire United States. The sales now under way contemplate an output within five years of 120,000 tons annually.

The entrance of the pulp and paper industry into the Alaskan region will be of almost immeasurable importance to the Territory. A capital investment of at least $8,000,000 or $10,000,000 will be necessary in connection with each of the two projects now inaugu-

rated. Part of this investment will be for the development of water power. The power sites, like the timber, are public property, and in consequence a coordinated development of both resources in the best interest of the Territory is made possible. The Federal Water Power Commission and this department are pursuing a joint policy under which pulp-wood areas and the water power necessary to make their operation feasible are blocked up together and made available to the same manufacturer, after advertisement and competitive bidding.

The consummation of these two sales will write the end of a long chapter in the history of the effort to make conservation a means for promoting the sound development and permanent prosperity of Alaska. For a good many years there was widespread misunderstanding of the aims and methods proposed, and natural doubt in Alaska of the outcome. Many believed that the Territory was being strangled under a locking up of its natural resources. The contrary was true. Private acquisition of the timber and water-power resources of the Tongass National Forest would have been chiefly for speculative profits.

Permanent Development in Alaska

The national-forest timber has always been open to sale on liberal terms to any purchaser wishing to use it, and has been sold in increasing and substantial quantities. It is the sole support of a flourishing local lumber industry and afforded a cut last year for all purposes equivalent to more than 50,000,000 board feet, log scale. At the same time the Forest Service has energetically sought to interest outside capital in the possibilities of pulp and paper production. The long effort has now apparently succeeded. Unlike any other heavily timbered region of the United States, the Alaskan coast will not become the scene of temporary exploitation leading to timber depletion, but can look forward to the development of permanent forest industries in keeping with the capacity of the forest lands to sustain them.

National-Forest Idle Land

In my report of last year I called attention to the large areas of burned-over land on the national forests needing to be planted in order to restore them to productivity. While in the main these nonreforesting burns are a heritage from long ago, each bad fire season such as that of 1926 adds new areas. Through the acquisition of cut-over lands to build up eastern forests the need for planting to make all the land productive is further increased.

The present appropriation for national-forest tree nurseries and planting is too small to make an appreciable impression on the 2,000,000 acres of idle land within the forests. Not to get tree crops started on this land is bad economy from every standpoint. The land adds to the public cost of administration without a counterbalancing prospect of future timber. To urge reforestation for private owners while allowing the Federal properties to remain with considerable areas bare of valuable tree growth, though its restoration at a moderate outlay is entirely feasible and would con-

stitute a prudent investment of public funds, is lacking in consistency. This work should be enlarged at the earliest possible time.

National-Forest Grazing Fees

The proper basis on which to determine the fees charged for grazing livestock on the national forests has been under discussion between the department and the stockmen for some years. After a painstaking appraisal of the 30,000 odd grazing allotments, extending over four years, the Forest Service proposed a new scale of fees based primarily upon what is being paid for the use of similar private range. This involved a considerable increase of the fees in most national-forest regions, which many stockmen vigorously opposed.

To obtain an independent and impartial review of all the questions at issue, I obtained the assistance of Dan B. Casement, an experienced and entirely disinterested western stockman, who after six months of painstaking inquiry submitted a report approving the range appraisal methods developed by the Forest Service and the principles underlying the fees proposed. Mr. Casement recommended, however, some changes in the scale of fees proposed, to harmonize them more fully throughout the various regions, and certain reductions to bring the principle of commercial valuation into better balance with the social and economic benefits sought in the administration of the national forests. Mr. Casement's report, in which the Chief of the Forest Service concurred, was then submitted to the livestock men for their study and consideration.

Early in January, 1927, I met with the stockmen in conference in Salt Lake City. After two full days' discussion, I approved the schedule of fees originally developed by the Forest Service, as modified by Mr. Casement's recommendations, with such further modifications as might be found equitable to adjust all fees fairly between the different national forests and regions. The new scale of fees will be put into effect, where increases are called for, through graduated annual increases for four years beginning January 1, 1928. The final fees will be fully in effect on and after January 1, 1931. Since the present term permits expire in 1935, I informed the stockmen that no changes in grazing fees for the ensuing 10-year period would be made unless the basic conditions had materially altered by that time.

Adjustment of Charges

One of the important features of the new schedule of grazing fees is to adjust the charges more specifically to the value of each range allotment, in lieu of the flat regional rates largely applied heretofore. Hence there will be considerable diversity in the individual fees. Averaging all grazing allotments, however, the effect of the change will be to raise the present average rate for cattle from 10.4 cents to approximately 14.4 cents per month, and the average rate for sheep from 2.9 to 4.5 cents. No charge is made for livestock of either class under 6 months of age.

The decision has been accepted in good part by at least most of the livestock permittees. Range and business conditions in the live-

stock industry have improved materially; and the advantages of the greater stabilization of range use on the national forests under the 10-year permit system are becoming more and more evident.

HOME ECONOMICS

The Bureau of Home Economics is the national agency for collection and distribution of data on food composition. These data are not only necessary for all studies in human nutrition but are basic terms in the application of principles of nutrition in everyday menus and corrective diets. During the last year all available figures on the composition of retail cuts of beef, veal, and lamb, and the more usual fruits and vegetables, have been analyzed and prepared for publication.

Accumulated facts on American food habits show that the average farm family is much better fed than the average city family of the same income level. The food contributed from the farm to family living adds considerably to the income of the family on the farm. Studies on methods of keeping accounts have resulted in the preparation of an account book based on the forms found most useful by the women cooperating in this study. A number of women are keeping accounts which will be used as the bases for suggested household budgets.

Long-continued time studies with housewives are furnishing a very good picture of how the rural housewife is spending her time. In lightening her load, electric equipment is of great value and is becoming increasingly available. Studies have been inaugurated to show which kinds of electrical equipment will be of most value to her, and which may be operated most economically.

The Bureau of Home Economics has been called upon by other bureaus to cooperate in studies having to do with utilization of various food products. Meat studies have been made to determine the influence of production factors on palatability. Cooking tests have been started on the domestic almond to determine what changes are necessary in the methods applied to foreign almonds in order to yield the most satisfactory product Advice has also been furnished to different cooperative organizations in regard to the form in which the housewives can utilize their products to the best advantage and at the same time decrease certain of the marketing costs. The organization of cooperative marketing makes possible better control of marketing methods, as well as the adaptation of production to the amount the market can absorb.

THE GRAIN FUTURES ADMINISTRATION

In connection with the enforcement of the grain futures act and the supervision of transactions in futures on the 12 exchanges designated as contract markets, daily reports were received from all clearing members showing the volume of trading for customers, together with the changes in open commitments from day to day. During the fiscal year the total volume of trading in grain for future delivery on all contract markets aggregated 19,964,384,000 bushels against 24,604,867,000 bushels during the previous year. Of the total trading in all grains, 12,584,391,000 bushels, or 63 per cent,

represented trading in wheat futures in comparison with 18,344,839,000 bushels, or 74½ per cent, for the year preceding.

The transactions in wheat futures on the Chicago Board of Trade aggregated 10,619,503,000 bushels, or a little more than 84 per cent of the total trading in wheat on all markets, against 15,869,030,000 bushels, or 86½ per cent the previous year. The total volume of trading in wheat was considerably smaller during the past year, and the daily price fluctuations were less pronounced. During the first half of the crop year, when the greater portion of the wheat was being marketed, the average daily price range of the dominant futures at Chicago was only 1⅞ cents as compared with an average daily range of 3⅜ cents for the corresponding period as applied to the 1925 crop.

Early in the year the New York Produce Exchange was designated as a contract market under authority contained in the grain futures act. The trading in wheat futures on the New York Produce Exchange was started on August 2, 1926, and was applied to both domestic and bonded wheat. It is the only market east of Chicago trading in grain futures and while the volume of trading has not been large it gives promise of becoming a factor of no little importance through the affording of suitable hedging facilities in connection with the heavy export movement of grain through the port of New York.

RECENT FEDERAL LEGISLATION

Among the acts passed at the last session of Congress was a measure (S. 4746) authorizing the Secretary of Agriculture to collect and publish statistics of the grade and staple length of cotton covering both the current crop and the carryover, and limiting to five the number of reports to be issued on the condition, progress, and probable number of bales of the current crop. Another act passed affecting cotton (S. 4974) amended the cotton futures act by providing that differences above or below middling in future contracts shall in all cases be settled on the basis of the average commercial difference of not less than five of the bona fide spot markets designated by the Secretary of Agriculture for this purpose. An act was also passed (S. 2965) prohibiting boards of trade or similar organizations from excluding from their membership and privileges representatives of cooperative associations or producers' organizations acting for a group of such associations.

The last Congress also added to the regulatory laws administered by the department the act of February 15, 1927, to regulate the importation of milk and cream into the United States; the act of March 4, 1927, to safeguard the distribution and sale of certain dangerous caustic or corrosive acids, alkalies, and other substances in interstate and foreign commerce; and the act of March 3, 1927, to prevent the distribution or dumping, without good and sufficient cause therefor, of farm produce received in interstate commerce by commission merchants and others and to require them truly and correctly to account for all farm produce received by them. Aid was rendered the administrative officials of the department in formulating the regulations required by these three acts, and one of the assistants in this office participated in hearings held in Boston and New York on the milk-importation regulations.

Weeks Forestry Law

The National Forest Reservation Commission, at its two meetings held during the year, authorized the purchase by the department of a total of 135,000 acres in 12 States. During the year there were prepared, executed, and approved 200 agreements of purchase for the acquisition of lands covered by authorizations of the commission; and titles to lands in excess of 365,000 acres were examined, 178,512 acres of which have been acquired by the United States. Approximately 52,000 acres of land, titles to which have been examined, are now in condemnation, and 135,000 additional acres are in process of acquisition. The amendment of the Weeks forestry law so as to permit payment of awards in condemnation cases, upon the approval of the proceedings by the Attorney General, has materially expedited the handling of condemnation cases.

OFFICE OF INFORMATION

The Office of Information has continued to utilize three channels—department publications, the press, and radio broadcasting—in disseminating the results of scientific studies.

During the year congressional and miscellaneous demands called for the distribution of 27,877,340 copies of the department's various publications. Included in this figure are all classes of bulletins, circulars, periodicals, and other publications of an informational nature. There were printed during the year a total of 28,871,920 copies of department publications.

Farmers' Bulletins are the most popular of the several types of publications issued by the department. Of the 11,360,952 of these distributed, 7,841,328 were sent out by Senators or Representatives in Congress, and 3,519,624 in response to requests sent to the Office of Information.

A new series called Department Leaflets was started. These publications are confined to practical directions and recommendations in regard to specific remedies or methods. They are written in an informal, popular style and are limited to four or eight pages of text matter and illustrations. It is believed that this series will accomplish a marked saving in the cost of making available to hundreds of thousands of persons the department's vast amount of information.

It was decided to discontinue the Department Bulletin series with No. 1500 and to replace it with a series called Technical Bulletins. Department Circulars were discontinued with No. 425 and replaced by Circulars. The name of the Miscellaneous Circular series was changed with No. 110 to Miscellaneous Publications. The changes were made in the interest of greater clearness and definiteness. Each new series began with No. 1.

After several years of issuance in multigraph form, the Agricultural Situation, issued monthly, was changed to a printed publication carrying the same general type of economic information. This change was made in order to provide for a wider distribution of this type of information than was possible in multigraph form. In the printed form it is available to anyone interested at the subscription price of 25 cents per year.

The Forest Worker, another publication issued in mimeograph form, was changed to a printed form, so that the information it contained could be made available to all who care to subscribe for it. The subscription price is 25 cents per year.

The weekly issue of Crops and Markets was discontinued on December 31, 1926. With this change there was some expansion in the size of the monthly issue, and arrangements were made for issuing in mimeograph form the important market reports formerly given in the weekly issue.

The Press Service

A healthy interest in the welfare of agriculture is reflected in the increasing attention given to the industry in the press. Daily newspapers are devoting more space to agriculture—particularly to developments in the scientific and economic fields. In this use of agricultural information the department is a willing cooperator.

Information of news interest and of educational value originating in the department is made available to the press through the department's press service in the Office of Information. "Spot news" is given immediate distribution to all national press associations and to some 200 press representatives in Washington. In addition it is mailed in mimeographed form to all presumably interested publications. Other information, such as that relating to the general agricultural situation, new developments in research, regulatory measures, or extension projects, as well as reviews of department bulletins, is mimeographed and given wide but selected and classified distribution.

Daily, weekly, and semiweekly newspapers, farm journals, trade and technical magazines and miscellaneous publications, of which there are more than 22,200 in the United States, are reached either directly or indirectly in this way, with the result that this agricultural information ultimately reaches millions of readers. Mimeographed releases of this kind averaged between four and five a day, or totaled more than 1,200 in the last year. Many special articles also were written for limited or exclusive use.

Still another outlet for information is the printed weekly Clip Sheet which goes to all weekly and semiweekly newspapers, and to other publications serving a large circulation. It contains short stories of timely interest and educational value. Another service inaugurated last year for country weeklies and mimeographed under the title "Page, Line, and Paragraph" is so much in demand that its distribution has been extended recently to include county-seat weeklies and semiweeklies. It now goes to some 10,600 papers of this class, all of which serve a large rural circulation. It consists of seasonal and useful information on agricultural practices and home making.

Representatives of the press, free-lance writers, and other contributors to publications using agricultural matter, are encouraged to call at the press service headquarters for suggestions for special articles. Assistance is given them in obtaining subject material and illustrations for featuring such special articles, a service which results in the publication of much valuable agricultural matter.

The Radio Service

One of the projects carried out by the department's radio service in its first full year of broadcasting a comprehensive technical information service, was an inquiry into the use of this service, and of radios in general, by farmers. During the 1926–27 season, the radio service sent 10,000 questionnaires to individual farmers, county agricultural agents, and managers of broadcasting stations. The replies are incorporated in a report, The Number and Uses of Radio Sets on Farms in the United States, April 1, 1927. On April 1, 1927, there were 1,251,186 radios on farms in the United States, an increase of 128 per cent over the number on farms July, 1925.

The report was used as a guide in planning the radio programs. This season's programs include three of last year's favorites: Aunt Sammy's daily housekeepers' chat, the noontime farm flashes, and the United States radio farm school, as well as eight special features. The special features for 1927–28 are: The poultry chats, a new program worked out in answer to numerous requests for a special poultry program; the young folks' program; insect and wild-animal allies and enemies; primer for town farmers; the farm news digest; and chats by the weather man. Two new special monthly programs are scheduled: The agricultural situation review; and special monthly farm playlets dramatizing agricultural problems.

The services are well received by broadcasting stations. More than 100 commercial stations were broadcasting the department's programs in October. Hundreds of letters received from farmers cite instances of how these programs are put to use. Farmers report increased profits through improved marketing practices learned in farm radio lessons. More cotton on fewer acres, better food in the home, and better crops at lower cultivation costs, are listed among the benefits received. Thousands of individual requests have been received for literature mentioned in the services. Fifty thousand free copies of Aunt Sammy's Radio Recipes and 165,219 free Farm School pamphlets have been issued.

LIBRARY

The resources of the library of the department have been increased during the past year by the addition of 14,168 books, pamphlets, and bound periodicals and by the current issues of approximately 3,400 periodicals. As in previous years, more than half of these were received by gift or in exchange for department publications. The library is particularly rich in its collections of periodicals and official and society publications. Exchanges are received from every State in the Union, from our neighbors on the north and south of us, from the British Isles, from all the countries of Europe, from Asia, from Australia, from the islands of the Pacific, in fact from every civilized country. These books, periodicals, bulletins, and reports are invaluable sources of information on the subjects under investigation by the department.

Three additions were made during the year to the mimeographed series of Bibliographical Contributions of the library, namely, No. 12, entitled "Peat: A Contribution towards a Bibliography of the American Literature through 1925"; No. 13, entitled "A Classified

List of the Soil Publications of the United States and Canada"; and No. 14, entitled "List of the Publications on Soils Issued by the United States Department of Agriculture, 1844–1926." The last two were specially prepared for distribution at the First International Congress of Soil Science held in Washington, June 13–22, 1927. In the Bureau of Agricultural Economics library the following additions were made to the mimeographed series of Agricultural Economics Bibliographies: No. 17, "Farm Youth: A Selected List of References to Literature Issued Since January, 1920"; No. 18, "Price Fxing by Governments, 424 B. C.–1926 A. D.," "A Selected Bibliography, including some References on the Principles of Price Fixing and on Price Fixing by Private Organizations"; No. 19, "The Apple Industry in the United States: A Selected List of References on the Economic Aspects of the Industry."

PERSONNEL OF THE DEPARTMENT

On June 30, 1927, the department had on its rolls 21,661 employees, of whom 4,791 were located in Washington and 16,870 stationed in the field service. This number is an increase over the employees on June 30, 1926, of 84 in Washington and 835 in the field service.

The expansion of certain activities for which increased appropriations were provided by Congress, and additional duties required of the department by legislation were responsible for the additional personnel employed, more than one-half of which was required for the enforcement of the European corn-borer control act. As noted in my last report, the employment situation in the department is becoming more stabilized, as shown by the decrease in the turnover in the personnel from 11.41 per cent in 1926 to 10.69 per cent in 1927. In the Washington force about 60 per cent of the total turnover occurred in the first three grades in the clerical and custodial services.

During the year 59 employees were retired from the service, 30 due to age and 29 on account of disability. In 1926 the retirements were 16 due to age and 16 on account of disability. This increase seems largely due to greater readiness on the part of employees whose usefulness has been impaired by age or infirmity to avail themselves of the increased annuity recently provided under the retirement act.

Many employees have received advancement through promotion to higher grades involving more exacting duties. In a reasonable number of cases moderate increases in compensation have been granted, in recognition of competent and efficient service. Since there are practical limits beyond which compensation can not reasonably be increased without the assumption of new duties and added responsibilities, employees have been encouraged to fit themselves for further advancement by pursuing educational courses or by broadening their knowledge of the technical details of departmental work.

W. M. Jardine,
Secretary of Agriculture.

FINANCIAL STATEMENT

Expenditures, Department of Agriculture, Fiscal Year 1927

Funds expended and obligated for work under the supervision of the Department of Agriculture for the fiscal year which ended June 30, 1927, including road building, totaled $153,049,018.04, classified as follows:

(1) *Regular work*

For "regular work," or activities for which the department is directly and independently responsible, as follows:

Office of the Secretary	$1,099,604.49
Office of Information	1,097,838.48
Library	83,490.08
Office of Experiment Stations	344,090.38
Extension Service	1,579,951.35
Weather Bureau	2,598,192.04
Bureau of Animal Industry	[1] 12,405,536.86
Packers and Stockyards Administration	403,786.96
Bureau of Dairy Industry	518,308.18
Bureau of Plant Industry	3,804,661.27
Forest Service	10,522,303.61
Bureau of Chemistry	1,464,364.93
Bureau of Soils (including Fixed Nitrogen Research Laboratory)	591,981.44
Bureau of Entomology	2,656,425.57
Bureau of Biological Survey	947,700.16
Bureau of Public Roads	448,958.90
Bureau of Agricultural Economics	5,014,293.94
Bureau of Home Economics	126,890.89
Insecticide and Fungicide Board	189,171.44
Federal Horticultural Board	774,290.75
Grain Futures Administration	101,693.87
Farmers' seed grain loans	264,425.53
Total expenditures for regular work	47,037,961.12

(2) *Other than regular work*

For work administered by department, supported by Federal funds provided as direct aid to States or for special forestry and wild-life conservation work and similar objects, as follows:

(a) Special conservation—		
Cooperation with States in fire protection of forested watersheds of navigable streams	$704,224.24	
Cooperation with States in farm forestry, extension and distribution of forest planting stock	116,436.25	
Acquisition of lands for protection of forested watersheds of navigable streams	1,001,290.79	
Acquisition of land for upper Mississippi River wild life and fish refuge	88,031.27	
		$1,909,982.55
(b) Colleges and stations—		
Payments to State agricultural experiment stations for research work under Hatch, Adams, and Purnell Acts	2,880,000.00	
Payments to State agricultural colleges for extension work in agriculture and home economics under Smith-Lever Act	5,880,000.00	
		8,760,000.00

[1] Including $3,605,000 paid to livestock owners as indemnities for animals destroyed in connection with tuberculosis eradication, and $5,034,810.07 for meat-inspection service.

For work administered by department, supported by Federal funds provided as direct aid to States or for special forestry and wild-life conservation work and similar objects—Continued.

(c) Forest Service receipt funds—			
Payments to States for benefit of county roads and schools (national-forest receipts)	$1,299,090.69		
Roads and trails for States (national-forest receipts)	447,852.80		
Cooperative work, consisting principally of forest road and trail construction, also improvements, fire prevention and suppression, disposal of brush in timber-sale operations, and investigative work (paid from private contributions)	1,461,167.15		
Refunds to users of national-forest resources of moneys deposited by them in excess of amounts required to secure purchase price of timber, use of lands, etc	60,396.91		
		$3,268,507.55	
(d) Road construction—			
Federal-aid highways—			
Payments to State highway departments for road construction	$2,698,559.70		
Highway research and investigational studies	279,006.25		
	$2,977,565.95		
Forest roads and trails	9,095,000.87		
		92,072,566.82	
Total expenditures for other than regular work			$106,011,056.92
Total expenditures for all purposes			153,049,018.04

Expenditures for Regular Work

(1) *Net cost of work*

As indicated by the foregoing table, total expenditures during the fiscal year 1927 for what may be designated as the "regular work" of the department (as distinguished from work supported by Federal funds administered by the Department of Agriculture but made available for direct use by the States or for special conservation purposes), were $47,037,961.12. Partially offsetting this amount, earnings in connection with these activities during the year, aggregating $5,687,412.05, deposited in the Treasury of the United States to the credit of "miscellaneous receipts," and $182,818.79 received as fees for classifying cotton and credited to the revolving fund for that purpose, make the actual net cost to the Federal Government of the department's regular work $41,167,730.28.

(2) *Distribution by types of activity*

The total expenditure of $47,000,000 for regular work was distributed by types of activity approximately as follows.

Types of activity	Amount	Per cent
(a) **Research** (including investigations and experiments in animal and plant production, breeding, and improvement, in methods of controlling diseases, insects, and other animal and plant pests, for soil and fertilizer studies, for farm management practice, marketing, and crop utilization investigations, and other scientific studies and investigations of the fundamental problems of agriculture, horticulture, forestry, etc., by means of laboratory and field experiments)	$10, 600, 000	22. 6
(b) **Extension work** (demonstration and educational work by means of county agricultural, home demonstration, and boys' and girls' club agents, through exhibits, motion pictures, or otherwise, with a view to the dissemination, by direct contact of the information developed by the experiments and discoveries, of the department and the various States)	2, 400, 000	5. 1
(c) **Eradication or control** (direct control or eradication of plant and animal diseases, insects, and other pests, through organized campaigns, either independently or in cooperation with State agencies)	9, 000, 000	19. 1
(d) **Service work** (including such activities as the administration and protection of the national forests, the weather service, crop and livestock estimating, market news service, shipping-point and terminal-market inspection service on farm products, and other work of like character for the benefit of the public, not primarily involving research or the enforcement of special laws of a regulatory nature)	15, 000, 000	31. 9
(e) **Regulatory work** (administration of some 40 regulatory laws, such as the food and drugs act, meat inspection law, plant and animal quarantine acts, migratory-bird treaty act, cotton futures and cotton standards acts, grain standards act, warehouse act, etc.)	10, 000, 000	21. 3
Total	47, 000, 000	100. 0

Expenditures for all Purposes, Distributed by Types of Activity

The total expenditure of approximately $153,000,000 for the fiscal year 1927, covering all funds disbursed or administered by the department, was distributed by types of activity about as follows:

Items	Research	Extension	Eradication or control	Service activities
Regular work, or ordinary activities of department	$10, 600, 000	$2, 400, 000	$9, 000, 000	$15, 000, 000
Special forestry and wild-life conservation	[1] 35, 000	[2] 45, 000		[3] 1, 820, 000
Colleges and stations (payments to States under Hatch, Adams, Purnell, Smith-Lever, and supplemental acts)	[4] 2, 880, 000	[5] 5, 880, 000		
Forest Service receipt funds	[6] 35, 000			[7] 3, 225, 000
Federal-aid and forest roads	[8] 280, 000			
Grand total	13, 830, 000	8, 325, 000	9, 000, 000	20, 045, 000
Percentage of grand total	9. 0	5. 4	5. 9	13. 1

Items	Regulatory work	Road construction	Total	
			Amount	Percentage of grand total
Regular work or ordinary activities of department	$10, 000, 000		$47, 000, 000	30. 7
Special forestry and wild-life conservation			1, 900, 000	1. 3
Colleges and stations (payments to States under Hatch, Adams, Purnell, Smith-Lever, and supplemental acts)			8, 760, 000	5. 7
Forest Service receipt funds			3, 260, 000	2. 2
Federal-aid and forest roads		[9] $91, 800, 000	92, 080, 000	60. 1
Grand total	10, 000, 000	91, 800, 000	153, 000, 000	100. 0
Percentage of grand total	6. 6	60. 0	100. 0	

[1] Forest taxation and timber insurance studies, under appropriation "Forest fire cooperation" (Clarke-McNary reforestation act).
[2] Cooperation with States in farm forestry extension work (Clarke-McNary reforestation act).
[3] Cooperation with States in forest fire protection and distribution of forest planting stock under Clarke-McNary reforestation act; purchase of forest lands, under Weeks forestry law; and purchase of lands for Upper Mississippi River Wild Life and Fish Refuge.
[4] Payments to State agricultural experiment stations for research work under Hatch, Adams, and Purnell Acts.
[5] Payments to State agricultural colleges for extension work under Smith-Lever Act.
[6] Forest investigative work under appropriation "Cooperative work, Forest Service."
[7] Used principally for county road and school purposes in national-forest States.
[8] Highway research and investigational studies under appropriation for Federal-aid highways.

Income from Department's Activities, Fiscal Year 1927

Incident to the department's work during the fiscal year 1927 direct receipts totaling $8,509,673.29 were covered into the Treasury and fines were imposed and judgments recovered by the courts amounting to $111,554.03 in connection with the enforcement by the department of the regulatory laws which devolve upon it for administration and execution, as follows:

(1) *Receipts*

(*a*) Deposited to credit of miscellaneous receipts fund:			
Regular work—			
From business on the national forests	$4,652,565.06		
From other sources	1,034,846.99		
		$5,687,412.05	
Other than regular work—			
Ten per cent of net receipts from business on the national forests, appropriated as a special fund for forest road and trail construction in 1928	514,040.68		
Proceeds from sale of surplus war materials transferred to States for road-construction work	23,917.29		
Contributions from private cooperators, appropriated as a special fund for road and trail construction, fire protection and suppression, brush disposal, and investigative work on national-forest and privately owned lands	1,507,463.34		
		2,045,421.31	
Total deposited to credit of miscellaneous receipts fund			$7,732,833.36
(*b*) Deposited to credit of applicable funds of department:			
Fees collected for classifying cotton, deposited to credit of revolving fund for conducting this work		$182,818.79	
Reimbursement to various appropriations of department for expenditures made therefrom		594,021.14	
Total deposited to credit of funds of department			776,839.93
Total receipts			8,509,673.29

(2) *Fines*

Fines imposed and judgments recovered by the courts in connection with violations of statutes entrusted to Department of Agriculture for enforcement	111,554.03
Total direct income from activities of Department of Agriculture	8,621,227.32

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REPORT OF THE CHIEF OF THE BUREAU OF AGRICULTURAL ECONOMICS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF AGRICULTURAL ECONOMICS,
Washington, D. C., August 31, 1927.

SIR: I have the honor to transmit herewith a report of the work of the Bureau of Agricultural Economics for the fiscal year ended June 30, 1927.

Respectfully,

LLOYD S. TENNY,
Chief of Bureau.

Hon. W. M. JARDINE,
Secretary of Agriculture.

The work of the Bureau of Agricultural Economics during the past year has been marked by more vital cooperation between this bureau and other agencies throughout the country which are dealing with the economic problems of agriculture. This cooperation covers a wide range of activities from the dissemination of information on market supplies and prices of farm products to the study of the taxation problems. It is carried on under diverse arrangements, from the formal cooperative agreement for the joint prosecution of a research project to the informal conference with a small group of farmers. Many individuals render valuable service through cooperation with this bureau. For example, more than 300,000 farmers furnish information with regard to crop conditions, and a large number keep farm records and accounts in accordance with the recommendations of the business specialists of this bureau and submit valuable data on farm operations and farm-management practices. The close association of individuals and agricultural agencies with this bureau has made possible more concentrated work on local conditions and more effective dissemination of information connected with farm problems.

Great impetus was given to cooperative marketing work by the passage on July 2, 1926, of an act creating a division of cooperative marketing in this bureau. This division is now well organized, having a corps of able specialists who are not only thoroughly familiar with the principles of cooperative marketing but are in addition experienced in the production, handling, and marketing of farm products. These men are in constant touch with cooperative managers and directors in working out methods by which cooperative marketing and purchasing by farmers can be made more effective. Farmers are increasing their demands for information leading to better production, better grading and standardizing of products, improved marketing methods, and skillful administration of the market supply in connection with their cooperative activities. This attitude on the part of farmers promises much for the future of cooperative organization. Through the Division of Cooperative Marketing, all of the facilities of the bureau are drawn upon to furnish information which is helpful to farmers in successfully meeting their organization and production and marketing problems.

A study of receipts and expenditures for the agricultural industry as a whole indicated that for 1926–27 there was a decline in net agricultural income of approximately 20 per cent,

whereas in the preceding four years there had been successive improvements from the low levels of 1921–22. There was a decline of approximately 5 per cent in gross income, while the expenses of production declined only 2 per cent. The reduction in gross income from agricultural production appears to have been almost entirely a reduction in cash income from sales. When analyzed by groups of commodities, the decline in cash income appears to be due largely to the smaller incomes from the record cotton crop, from grain crops, and from apples and potatoes. Somewhat higher receipts from livestock and livestock products only partially offset the lower incomes from crops.

A special study covering returns made by 13,475 farmers in the United States indicated that after taking into account changes in inventory, the average receipts exceeded expenses by $1,113 in 1926 as compared with $1,297 in 1925. It should be noted that a wide variation is shown in the incomes of individual farmers. While many operated at a satisfactory profit, the receipts on over 11 per cent of the farms in 1926 were not sufficient to cover expenses, after taking into account changes in inventory.

Continuous attention has been given by the bureau to lines of work designed to aid farmers and their organizations in finding ways of improving the unsatisfactory farm conditions. A special effort has been made to provide farmers with information essential in adjusting their production programs to meet the changing demand for farm products. It is desirable for farmers to decide the amount and kinds of commodities which they will produce in the light of all available information with regard to supplies of farm products on hand, forecasts of intentions of farmers throughout the United States to produce similar commodities, information with regard to the production of these commodities in foreign countries, and estimates of the probable demand for them at the time when they will reach the market. Farmers should be prepared to change their farm enterprises in order to meet changing economic conditions.

It is to help the farmers in making advantageous shifts in their production that the outlook reports are prepared in this bureau. Each year all available information in every division of the bureau is brought together and used in outlining the situation with regard to each of the major farm crops. The report points out the probable future trends of demand and supplies of agricultural products. It takes into consideration and presents the facts on world-wide and national conditions which farmers should consider along with their local conditions in planning their year's production. This report is issued in January or February of each year, so as to give farmers time to make adjustments.

Supplementing this outlook report surveys are made and reports issued just previous to planting time for various crops of the intention of farmers to plant. Twice annually the pig survey is made which shows the intentions to breed pigs. These reports are sent out, not as forecasts of probable production but as statements of farmers' intentions as of a certain date. They furnish producers an opportunity to modify their plans if it appears desirable. It is well known that progressive farmers do modify their programs in the light of the information indicated by these surveys. A beginning has been made in cooperation with various States to supplement the national outlook work by local informatiton which will be of particular value to farmers in the State in readjusting their plans.

Intensive research work must be done and searching analyses made of the factors which influence the prices for farm products. Special studies have been made of oats, cotton, and hog prices that have been especially useful to students of economic conditions and agricultural workers.

Coordinate with the work of helping to adjust production to meet changing demands, the market information service is carried on to help the farmer in disposing to the best advantage of the products which he has produced. Comprehensive reports are issued monthly covering the major farm products and dealing with current and prospective conditions as to demand, supplies, and prices in domestic and foreign markets. The market news service furnishes producers, distributors, and others with daily and often hourly information with regard to prices on the principal markets, supplies arriving at central markets, cars which are en route, demand, and general developments in the various market centers. This service is now well recognized and has developed to a point where it is indispensable to the intelligent marketing of farm products and therefore a very important factor in the Nation's commercial life. Through

the cooperation of the radio-broadcasting stations "up-to-the-minute" market information is available to practically all farmers.

Another service which is of growing importance to agricultural interests is the market inspection of farm products. This service is offered at both shipping and receiving point for many products. This work has greatly facilitated marketing, in that it furnishes reports on the quality and condition of shipments which are accepted by all parties to a transaction as fair and unbiased statements of the actual facts. The service has gone far toward establishing confidence, settling disputes out of court, and preventing waste of commodities which are involved in controversies.

A new development, which has already attained popularity, has been the inauguration of an experimental meat grading and stamping service. Under this service the grade is stamped on the carcass inspected with a roller stamp in such a way that the grade designation appears on the retail cuts. Consumers can consequently see the grade of the meat which is being purchased. This experiment was taken up at the urgent request of livestock producers and others as a means of promoting the production of superior beef and in order that the producers of high-grade beef might receive the premium which is due to superior products.

Marked interest has been shown during the past year in the bureau's program of standardization. The standards promulgated or recommended by this bureau have been made the legal standards in a large number of States, and cooperative organizations have adopted the standards as a basis for pooling their products. The shipping-point inspection work of this bureau has hastened the adoption and use of uniform standards by producers and shippers, who are realizing more and more the value of marketing their products on the basis of well-recognized grades. The second Pan American standardization conference, which was held in Washington May 9, 1927, strongly indorsed the standardization work of this bureau. Great interest has been shown in the various standards, and requests have been received for descriptions and practical forms of the standards from many foreign countries. Standards for various commodities are of increasing importance in connection with the exporting of American farm products.

In addition to controlling the production programs and improving marketing facilities the farmer must have means of carrying his products until a suitable market can be found. As a means of accomplishing this, the work under the Federal warehouse act has been of great assistance. The work of inspecting and licensing warehouses for the storage of farm products has had a marked growth during the last five years. Twelve products are now eligible for storage under this act and the number of warehouses applying for licenses is steadily growing. Paper representing products stored in federally licensed warehouses is readily acceptable as collateral for loans and furnishes the credit needed by farmers in carrying their products until such time as they can be sold to the best advantage.

PRODUCE AGENCY ACT

The produce agency act (44 Stat. 1355), approved March 3, 1927, makes it a misdemeanor, after June 30, 1927, for any person or firm receiving perishable farm produce in interstate commerce, or in the District of Columbia, for or on behalf of another, to make any false report or statement to the person from whom the produce was received, knowingly or with intent to defraud, concerning the handling, condition, quality, quantity, sale, or other disposition of the produce, or, knowingly and with intent to defraud, to fail truly and correctly to account therefor, or to dump or destroy produce without good and sufficient cause. Regulations for the enforcement of the produce agency act have been promulgated by the Secretary of Agriculture in Service and Regulatory Announcements No. 107 (Agricultural Economics). In view of the passage of this act, the proposed standard trading rules agreements which had been entered into by a large number of members of the fresh fruit and vegetable trade have been held in abeyance.

DIVISION OF FARM MANAGEMENT AND COSTS

H. R. Tolley, *in charge*

The difficulties experienced by farmers during the agricultural depression of the past six years have emphasized the importance of the adjustments in farming systems and practices which farmers must make as economic conditions change. Violent fluctuations in prices have centered attention upon this factor as one of the elements which farmers must take into account

from time to time in making their plans. Significant shifts in the demand for many farm products and the development of new production areas for others have focused the farmer's attention upon the necessity for frequent reorganization of farm programs in order to meet changing conditions. For this reason the more recent farm-management studies have pointed out the adjustments which farmers should make from time to time in order to keep their farming methods and practices and their production programs in line with the market requirements for the various products. The work of this division serves as a medium through which the bureau's various lines of economic information are focused upon the individual farmer's problem of what to produce so as to obtain the greatest profit. Information relating to market requirements, present and prospective demand and prices, production trends in competing regions, and production costs, methods, and practices are interpreted in the light of the conditions and factors governing successful farming in particular farming regions in such a way as to assist individual farmers and groups of farmers in determining sound production programs for their farms.

Partly as a result of the increasing commercialization of agriculture, the problem of regional competition between the farmers of different producing areas has taken on added significance in the past decade. For this reason a regional study of many farm-management problems centering around particular commodities or types of farming is necessary. The Federal department is peculiarly fitted to assume the initiative in work of this type, which, however, is carried on most effectively in cooperation with interested agencies in the various States. The more recent work of this division includes a number of projects of this type; for example, the studies of the apple industry, the peach industry, the combine harvester-thresher in the Great Plains region, and the use of the cotton sled and other large-scale methods of cotton production in the western part of the Cotton Belt.

STATE AND LOCAL AGRICULTURAL PROGRAMS

A detailed study of the agriculture of Idaho carried on in cooperation with the experiment station and other local agencies has been completed. Attention was called to the increasing demand for dairy products in far western markets within convenient shipping distance of Idaho producers. The marked increase in dairy production in the different sections of the State was also pointed out. Similar information relative to the market demand for each product grown in the State, prices, price trends, and price outlook, production in competing areas, farm-management problems and practices were assembled and analyzed. This information was presented to farmers in a series of reports and through the regular extension service. Assistance was given in the conduct of similar studies in the area around Billings, Mont., and in the territory adjacent to Columbia, S. C.

TYPES OF FARMING

Studies of the geographical distribution of types of farming have been continued. In these studies the agricultural census data for each county in each State is analyzed for the purpose of locating areas having similar types of farming. In this way the results of farm-management studies in particular localities may be used in the larger type of farming area of which the locality studied is typical. The changes in type of farming from one census period to the other are also analyzed with a view to determining the factors responsible for these changes.

In North Dakota, in cooperation with the agricultural experiment station, census and crop-estimates data as to crops and livestock in each county were analyzed and the State was divided into 13 types of farming areas. Typical farming systems in each of these areas were determined from a special analysis of records on several thousand farms located in these various areas. This comprehensive picture of the important types of farming carried on in each important section of the State aids in the development of sound educational programs which take into account the physical and economic conditions which affect farmers' decisions as to what crops and livestock they can produce to best advantage. Similar studies are being conducted in cooperation with the experiment stations in Oklahoma, Kansas, and South Dakota.

FARM RECORDS AND ACCOUNTS

Studies of farm organization and management problems by means of farm records and accounts were continued in selected areas in which changing economic conditions are mak-

ing adjustments necessary in the farming systems. In these areas a carefully selected group of farmers keep closely supervised records over a period of from one to three years. These accounting data are used, in connection with experimental data, price data, and other related information, in determining the advantages and disadvantages of the different systems of farming being followed and the possibilities of the new lines of production and the new systems being tried in the area. An important function of the accounting data in these studies is to aid in localizing and adapting data available from other sources.

Bulletins have been prepared showing the results of these studies in a beef-cattle section of southwestern Virginia, a dark-tobacco section of western Kentucky, a crop and livestock section of southeastern South Dakota, and the irrigated section of northern Colorado. The ways in which different farmers are meeting the new conditions are described in detail in these reports and illustrations, showing methods, practices, and systems that were profitable during the period of the study and conclusions based upon the record data, experimenal data, and the best available information from other sources as to the enterprise combinations that are likely to prove profitable during the years just ahead are presented. A bulletin on farm budgeting was prepared during the year outlining a method of procedure for farmers in organizing and using accounting data, experimental data, price data, and related information in working out solutions to particular farm problems.

New studies were started in a cotton and garden-truck section in southeastern Mississippi, a dairy section of southwestern Illinois, and in the dairy section around Richmond, Va. Wherever studies of this kind show that widespread adjustments are advisable for an area, interested farmers are assisted in working out new systems and in keeping records on these new systems. In each of these areas a selected group of farmers was assisted in working out and putting into operation such changes as appeared desirable in the light of the previous studies and conditions on the farms. The results of these studies are being used more and more by extension agents as a basis for sound extension programs and policies.

LOCAL APPLICATION OF OUTLOOK INFORMATION

A beginning was made in aiding States in the local interpretation and application of the outlook information prepared by the bureau. Local agencies were aided in outlining the additional information which farmers need in making profitable adjustments in their farm enterprises. Arrangements were made in a number of States for developing more of the background information needed in providing farmers with reliable current information on which to make their production plans. Particular attention is given to the farm-management problems involved in adjusting crop and livestock production on individual farms in response to changes in market and price conditions.

THE APPLE INDUSTRY

At the request of producers' organizations and others, a study of the apple industry was started during the year in cooperation with other divisions of the bureau and with State experiment stations and extension services. Statistics relating to the ages and varieties of trees in commercial orchards were obtained for all the important apple-producing sections. Analysis of these data will indicate the trend of production of important varieties in each section of the country during the next 10 or 15 years. Studies of the prices received by growers for apples of different varieties, sizes, and grades were made, and information on the supply of apples and on the demand for apples of different varieties, grades, and sizes was collected in a large number of representative cities. Studies of the place of orcharding in the farming systems of specific areas were made in five States and this work will be expanded during the coming year. All the various phases of the investigation, including the analysis of markets, competition between areas and varieties, trends in production and plantings by varieties, present and prospective price levels, production costs and practices, yields, and similar information will be interpreted and presented with a view to enabling the producers of different sections to make a better adaptation of production to market requirements. In the Cumberland-Shenandoah region of Pennsylvania, Maryland, Virginia, and West Virginia a study of the factors affecting the yield of apples has been made in cooperation with other bureaus and the State experiment stations.

THE PEACH INDUSTRY

The studies of the peach industry initiated during the previous year were completed and the results presented

to peach producers and distributers. Reports dealing with the peach industry in their respective States, based in part upon the information collected by the bureau in this study, were issued by 10 States. A circular dealing with the peach situation in the Southeastern States was prepared. This study revealed the fact that the number of bearing peach trees in southern commercial peach States has increased rapidly during recent years and that the indications are for further increases during the next few years. It was also found that competition on the markets is likely to be keen on account of increased production capacity of peach trees in some sections and increased plantings in others, and also on account of increasing competition from other fruits and melons. Possibilities of increasing net profits by improved cultural practices and strict grading were pointed out. The desirability of a more even flow of peaches to the market through a better control of distribution was also indicated by this study.

STUDIES OF COMBINE HARVESTER-THRESHER OPERATIONS

To determine the practicability and efficiency of the combine harvester-thresher in the Great Plains, a study was made of combine operations in selected districts in Texas, Oklahoma, Kansas, Nebraska, and Montana, and records were obtained from farmers who operated these machines during the harvest season of 1926.

In all of the districts where records were obtained the farmers who were using combines were unanimous in stating that the combine is a practical and efficient harvesting machine. It was found that the combine has reduced the cost of harvesting and threshing, the labor required for harvest is reduced, the cost of twine for binding and the cost of threshing is eliminated, the period of harvest and threshing is shortened, so that the work of preparing the fields for the following crop can be done in better season, and there is probably less waste under this method.

The expense of harvesting small acreages with a combine is greater than for either a binder or header. Where 75 or more acres are to be harvested, however, the small combine may prove more economical than other machines. The large combine may be more economical than a binder or header if more than 100 acres are to be cut. Where 300 or more acres are to be cut the fixed charges of the combine are reduced to a low figure and the combine reaches its highest efficiency.

A somewhat similar study was made in cooperation with the Bureaus of Plant Industry and Public Roads and with agricultural colleges in various States for the purpose of determining the advantages and disadvantages of harvesting grain sorghums by different methods. It was found that the losses from heads left in the field were much greater when combines were used than where grain headers were used. Grain sorghums harvested with combines were found to contain more moisture, foreign material, cracked grain, sand, and dirt than sorghums that were headed and then threshed. On the other hand the actual cash or out-of-pocket costs of harvesting grain sorghums with combines were found to be much less than with headers or binders. The results of this study indicate the method of harvesting grain sorghums that are most advisable under various circumstances.

FARMING ADJUSTMENTS IN MARKET HAY AREAS

A study of the problem encountered by the farmers in the hay-producing areas of Pennsylvania and New York was made. Data showing the consumption of hay by horses and mules in the cities and mines of northeastern United States indicate a declining demand for the market hay grown in these areas. Similar data relative to the trends in acreage production and shipments of hay from the various areas supplying these markets have been assembled. A field study of the requirements for hay production and of the production possibilities and returns from alternative enterprises was made in the important hay-producing areas of these two States. It is expected that these studies will make possible sound recommendations for profitable farming adjustments in these areas.

HARVESTING METHODS IN WESTERN COTTON BELT

Because of the marked increase in the use of the cotton sled in harvesting cotton, a study was made of the requirements and costs for picking, snapping, and sledding cotton in western Texas and Oklahoma. The possibilities of using the sled elsewhere and the outstanding advantages and disadvantages of harvesting cotton with the sled as compared with harvesting by picking or snapping were pointed out. It was found that only six or seven hours of man labor are required to sled

enough cotton to make a 500-pound bale of lint, whereas 70 or 80 hours are required for hand picking that quantity. On the other hand, cotton which has been sledded or snapped sells at a disadvantage as compared with that which has been picked, and even under favorable circumstances the sled leaves some cotton in the field.

Special studies of large-scale cotton farming were made in the Corpus Christi and San Angelo areas of Texas. The effect of the use of large-scale production methods on the organization of cotton farms in this area and upon the incomes obtained by farmers were indicated by this study.

REORGANIZATION OF VIRGINIA TOBACCO FARMS

The development of improved farming plans on tobacco farms of south central Virginia was continued in cooperation with the Virginia Polytechnic Institute. This work is an outgrowth of a two-year study of the cost of producing tobacco and of farm organization in this area and the results have been gratifying on most of the farms.

COST OF PRODUCING STAPLE CROPS

A study of the cost of producing corn, wheat, oats, cotton, and potatoes was continued along lines similar to the studies of previous years. Reports from 15,000 farmers were received and analyzed in connection with these studies. Bulletins on the costs of producing wheat, incomes from farming and the cost of using tractors, horses, and combines on wheat farms in Sherman County, Oreg., and on the cost of producing Virginia dark and light tobacco were issued. The necessity for the expansion of enterprises other than tobacco as well as the improvement of farming practices as a basis for increasing farm earnings in this area was emphasized.

LIVESTOCK IN THE SOUTHERN COASTAL PLAINS REGION

The study of the place of livestock in the agriculture of the southern coastal plains region which was made in cooperation with four Southern States assumed added significance because of the rapid decline in cotton prices in the fall of 1926 and the increased interest in livestock production in this region. Methods of handling livestock on successful and unsuccessful farms were studied in detail and reasonable standards of care and management set up as guides for livestock producers in these areas.

In the black prairie belt of Alabama and Mississippi it was found that because of the natural adaptability of the soil to the production of forage crops and the possibility of sufficient good pasture, the production of livestock offers an excellent means of more fully utilizing the natural resources of the area. Systems of farming, with dairying and beef production as the principal livestock enterprises and early lamb production as a secondary livestock enterprise, combined with the production of Johnson-grass hay and a limited amount of cotton, were found to offer opportunities for increasing returns on farms where livestock are cared for properly.

Information was assembled relative to consumption of livestock and livestock production in six typical cities of the southeastern section of the country and as to the whole-milk supply of the important cities of Florida. The possibilities of adapting production so as to better meet the needs of these near-by markets were pointed out. Available statistical data on the livestock industry in the coastal plains region, census and crop-estimates data as to livestock production, and related information on crop acreages, utilization of farm land, population changes, and other items were assembled for the different periods from 1870 to 1925. These data were made available to those interested in the development of livestock production in this region and proved helpful in determining the possibilities of profitable livestock production in different parts of the region.

This study developed the need for more information as to the possibilities of hog production in the peanut-producing areas of Alabama and Georgia. A detailed study of methods of hog production and of the most profitable types of farm organization for this area was undertaken in cooperation with the agricultural colleges of these States.

SYSTEMS OF HOG PRODUCTION ON CORN BELT FARMS

Studies of systems of pork production on Corn Belt farms were continued and timely reports of value to farmers in improving their methods of pork production were issued. The effect of the rate of feeding early spring pigs on costs, gains, time of marketing, and profits was given special study. The field work in connection with these studies in Iowa, Illinois, and Indiana is now practically complete, and atten-

tion is being concentrated upon the analysis of several years' data.

POULTRY PRODUCTION

Information bearing upon all phases of the poultry industry, especially in the Western States, was assembled and presented to research and extension agencies in those States. Especial attention has been given to the premium paid to farmers for high-quality production and to the farm-management practices essential in maintaining a high-quality product. A detailed study of methods and practices in poultry production in important producing areas in New York was made in cooperation with the New York State College of Agriculture.

RANGE-CATTLE PRODUCTION

Studies embracing the important range-cattle-producing areas of the United States were continued in cooperation with the Bureau of Animal Industry and State experiment stations and extension services. These studies point out desirable practices in ranch operation as well as the comparative advantages and disadvantages of various types of livestock in the different areas and the probable market demand for them. Those phases of the studies already completed indicate the types of ranch organization and production practices which are likely to prove most profitable in these areas. The phases of the study now under way include a detailed study of production methods, practices, and costs in 60 representative ranches in the northern Great Plains. The detailed information from these ranches will be used as a basis for improving the organization and management of other ranches in the area.

BEEF CATTLE IN THE APPALACHIAN REGION

A detailed study of the methods of fattening cattle and of the organization of beef-cattle farms in southwestern Virginia was completed. It was found that because of an important change in the market demand for different types of cattle an earlier maturing type of cattle offers better opportunities for profit than the type generally handled. Changes in cropping systems were also found to be desirable, as the present systems usually do not provide sufficient amounts of grain to supplement grass feeding.

DAIRY PRODUCTION

The survey of dairy farming in the Shenandoah Valley of Virginia was completed in cooperation with the Virginia Polytechnic Institute. This study indicated a number of factors which were responsible for inefficient production and pointed out specific ways in which the farms might be organized to produce dairy products to better advantage and to increase the returns from farming.

In cooperation with the Vermont College of Agriculture studies of the relation between changes in the price of milk and of feeds in the New England States and the quantity of milk which farmers produced were completed. These studies of the elasticity of milk supply showed that from one-half to three-fourths of the variation in production was directly due to economic conditions, and furnished cooperative associations and others interested in the marketing of milk a more definite basis for establishing sound price policies.

At the request of the extension directors of the 11 Western States a representative of the division prepared a report on the statistics of the dairy industry, with special reference to this area. All of the available statistical information relative to the dairy industry was assembled, and this information has been used extensively by State extension agencies in connection with agricultural program making.

A representative of the division aided the Texas and New Mexico agricultural colleges in an economic study of the agriculture of the Elephant Butte project. Special attention was given to the place which dairying should have in the agriculture of this project.

In cooperation with the Bureau of Dairy Industry and the Virginia Polytechnic Institute a study of dairy farming around Richmond, Va., was inaugurated. In this study the organization and operation of dairy farms is being related to the demand for dairy products in Richmond and the adjacent area. Methods and practices responsible for differences in farmers' earnings and the proper place of the dairy enterprise on farms in this area will be determined. The distribution and disposition of milk and milk products produced in the area are also being considered.

SPECIAL STUDIES AND SERVICES

In cooperation with the Ohio State University a study of the farm business and the cost of living by farm families was begun in three localities in the less prosperous agricultural sections of southeastern Ohio. In addi-

tion to the usual analysis of farm-management problems special attention will be given to the cost of living on these farms and comparisons of living costs and systems of farming followed will be made for the same farms. Opportunities for increasing and for more judicious spending of incomes will also be pointed out by this study.

Business surveys of farms in localities in Overton and Washington Counties, Tenn., were made in cooperation with the experiment station. A number of the farmers in these areas were aided in starting farm-account books with a view to gaining more information for use in improving their own farming systems.

The summary of all farm-business surveys which was published in 1926 was kept up to date. During the year summaries of 2,821 farm records from 51 localities in 11 States were added to the summaries previously assembled. Special studies of the incomes from the same farms over several successive years were made with a view to determining what factors are responsible for consistently high or consistently low incomes.

Information relative to dry-farming methods and practices in the Columbia and Snake River Basins was brought up to date.

At the request of authorities of the Soldiers' Home, Washington, D. C., a study of the cost of producing milk at the dairy farm of the Soldiers' Home was made and suggestions given as to how their milk can be produced more economically without lowering the quality of the product. The Bureau of Dairy Industry cooperated in this work.

FARM RETURNS

Reports on the general results of farming in 1926 submitted by farmers were summarized. A return of $1,133 to the owner-operator for the use of $16,308 of capital, and the labor of the farmer and his family, is the average shown by 13,475 farms for 1926, compared with $1,297 by 15,330 farms for 1925, $1,205 by 15,103 farms for 1924, $1,020 by 16,183 for 1923, and $917 by 6,094 for 1922.

The return of $1,133 per farm in 1926 includes $975 cash, the excess of cash receipts over cash outlay for current operating expenses, and an increase of $158 in the inventory of crops, livestock, machinery, and farm supplies from January 1, 1926, to January 1, 1927.

In addition, the farm family had food produced and consumed on the farm the estimated value of which on the farms reporting the item was $282 and fuel from the farm and use of house the values of which were not reported. On the other hand, interest averaging $216 paid on indebtedness and outlays for improvements averaging $128 were not included in the computation of current cash operating expenses.

In all of the geographic divisions the results were lower in 1926 than in 1925, except in the south central division, where the increase in inventory value during the year was relatively large. In the West North Central and the Southern States the returns were even smaller than in 1924. Rather generally in all divisions the receipts averaged smaller and expenses nearly the same or larger.

DIVISION OF CROP AND LIVESTOCK ESTIMATES

W. F. CALLANDER, *in charge*

The outstanding development in the work of this division during the past year has been the inauguration of a plan of decentralization, whereby much more of the primary data collected from farmers and others relating to acreage of all crops, numbers of livestock, and monthly condition and yield reports on crops other than cotton, corn, wheat, and oats will hereafter be gathered by the field offices, of which the division now has 41. For the first time in the history of the division all of the information relating to the acreage of the 1927 crops has been gathered and compiled by the field offices. Arrangements were made to have this information reviewed by statisticians from the Washington office during June, just prior to the issuance of the preliminary acreage reports for the year. In a number of the less-important States the lists of township correspondents, who have heretofore been reporting to the Washington office not only on acreage but on all other items, have been transferred to the field offices.

This plan of decentralization has been under consideration for several years, but was postponed until the field service could be fully organized and two men placed in all important States. The new arrangement will result in a saving of time, in that instead of having two complete reports prepared on every item, one in Washington and one in the field office, only one report, which will be based on larger returns, will be prepared in the field offices. The decentralization plan will not be

extended, however, to what are commonly called the "speculative" crops—namely, cotton, wheat, corn, and oats—except in the minor States. It is felt that it is necessary in order to properly safeguard these reports to have a check in the Washington office on the reports submitted by the field offices. The decentralization has resulted in a material reduction in the clerical staff of the Washington office and further reduction will probably be made.

ORGANIZATION AND PERSONNEL

The personnel of the division now consists of 286 employees, of which 195 are stationed in the field offices. It is probable that during the coming year there will be further reductions in the Washington clerical staff and increase in the field office. During the past year 5,400,000 schedules were mailed out by the Washington office. About 500,000 of these covered miscellaneous inquiries for other divisions of the bureau engaged in research work. About 3,000,000 schedules were sent out by the field offices during the past fiscal year. During the coming year the number of schedules sent out by the Washington office will be reduced to about 1,500,000 but the schedules sent out in the field offices will be very materially increased, as it is proposed to handle all of the rural-carrier surveys, both relating to livestock as well as to acreage, through the field offices. This will result in a saving to the Post Office Department, in that the schedules will go to a central office in each State instead of all being forwarded to Washington.

The work of this division is now carried on in cooperation with State agencies in 32 States. In 27 States the cooperative agreements are with the State department or board of agriculture, and in 5 States with the State colleges of agriculture. It is possible, by reason of these cooperative agreements, to greatly expand the work. Many of the lines of work now being carried on would have to be dropped were these agreements abrogated. It is also preventing the duplication of statistical reports and increasing the accuracy of the information collected.

CROP FORECASTS

Several changes have been made in the program of issuing crop forecasts, commonly referred to as the monthly crop reports. During the past two years the date of the first forecast of production has been changed to the 1st of July for all crops except winter wheat, for which the first forecast is still made on the 1st of May. The forecasts of hay, formerly made on the 1st of May, and of the spring grain crops, formerly made on June 1, have been discontinued. Correlation studies of the relation of condition to final yield for these crops were not high enough to warrant the continuation of these forecasts, especially since it is possible to make a more accurate statement of acreage on the 1st of July than on the 1st of May or June. According to the present program, the estimate of acreage of all crops is made at one time. There is a distinct advantage to this change in program in that the acreage data are all pointed to the July 1 estimate. Collection of this material can be made more thoroughly and analysis can be made more comprehensive, with resultant improvement in the accuracy of the preliminary statement of acreage and correspondingly less need for revision in December. The date for the first forecast of the cotton crop has also been delayed by one month as a result of congressional legislation, and is now made on the 1st of August, although a statement of the acreage in cotton is made on the 1st of July. All of the mid-month reports—that is, for July, August, September, October, and November—have likewise been eliminated as a result of congressional legislation.

In connection with the crop forecast made at time of harvest, additional information has been collected for a sufficient number of years on probable yield to enable the division to use currently reported probable yield figures for the major crops. For example, on the 1st of September an inquiry is now made not solely on condition, as formerly, but also on the probable yield of spring wheat, oats, and barley. A study of relationship between these probable yield figures and the final yield figures, as reported on the 1st of October for the past three years, has indicated that in many States the reported probable yield is a somewhat better indication of final yield than is the condition figure, although in other States, notably the more northern States, the condition figure gives as accurate or more accurate indication of the final outturn. As a result of this change in method, the forecast immediately preceding the preliminary estimate has been materially improved.

The division has extended its work along the lines of collection of collateral data bearing upon total production. In quite a few additional States the division is now obtaining informa-

tion on railroad shipments of various grain crops which has proved of material assistance in making a revision of the preceding year's crop. Considerable emphasis has been placed upon the disposition of crops by farmers in order to make accurate utilization of the figures on railroad shipments.

The field service has devoted considerable time and effort to the conduct of that portion of the bureau apple survey which relates to a cross-section by varieties of the bearing and nonbearing trees in commercial apple orchards of the country. In many States returns have been received from more than 60 per cent of all the orchards having 300 or more trees. Of particular importance at the present time is the information being collected with respect to the year when trees were planted, which will afford a picture of the number of trees, by varieties, of the various age groups, bearing and nonbearing, in the commercial orchards of the country.

LIVESTOCK REPORTS

The most notable advance in the livestock-estimating work the past year has been along the line of estimating the actual production of meat animals and the value of this production for meat purposes by States. This production is estimated in pounds and is evaluated by an average price per pound received by producers. By the method used in determining production, changes in inventory amounts at the beginning and end of the year are included, but changes in inventory unit values are excluded.

The basis of these estimates are State balance sheets for each species, showing as debit items the number on hand at the beginning of the year, the number born and the number brought into the State, and as credit items the number shipped to market, the number slaughtered locally and on farms, and the number that died.

These balance sheets involve estimates of the size of the calf, pig, and lamb crops for the year by States. The greater part of the information used as a basis for these estimates is obtained from the livestock-survey cards distributed by the rural mail carriers. This means of getting sample data on livestock is proving to be of very great value.

In addition to the pig-survey reports in June and December, showing the size of the spring and fall pig crops, the first estimate of the size of the lamb crop by States was made in July, 1926. The pig-survey reports for 1925 and 1926, as checked by subsequent marketings and slaughter, were very dependable indicators of changes in hog supplies. The 1926 lamb-crop estimate has been shown by subsequent marketings to be accurate, and the dependability of the reports on the lamb-feeding situation and the estimate of lambs on feed January 1 has been verified.

On the whole it is felt that the efforts directed to securing timely information as to livestock production and numbers are bringing increasingly dependable results and that the present program of livestock reports will furnish most of the information needed by livestock producers and the livestock trade.

FARM-PRICE REPORTS

The farm-price work has been materially strengthened during the past three years. About 120 per cent more price schedules are received each month than during 1924. This increase in both the representativeness and size of the price sample has been brought about by an increase of only about 20 per cent in the total number of price reporters on the list, more than 50 per cent now making returns, as compared to about half this number in 1924. The price records of the department from 1866 to 1925, by States, have been published in a series of four statistical bulletins entitled "Prices of Farm Products Received by Producers."

The crop year weighted annual price averages of farm crops have been recalculated and published on the basis of marketing information for the current year. These averages were previously computed on the basis of the usual or average rate of marketing over a period of several years. This improvement enables the current annual price to reflect more closely the conditions for the current year than was formerly the case. At the present time work is being started on computing crop-year average annual prices by States for the more important farm products. An effort will be made during the coming year to determine the seasonal movement of the prices of important farm products in the leading producing States.

PRICES OF ARTICLES BOUGHT BY FARMERS

The collection of data concerning the prices paid by farmers for things which they buy has been definitely standardized, and placed on a basis

which will enable the department to publish quarterly prices on more than 100 items of farm expenditure. The original inquiry which has been in use since 1910, with some revisions made in 1922, has been divided into five separate inquiries. This not only shortens the schedule going to the individual reporter but also greatly increases the percentage of items for which returns are made on a given schedule. It will require several years of effort to build up the lists for this inquiry to a point where they will be on as satisfactory a basis as are the farm-price reports of the department. These price data beginning with 1909 for most items will be published on a geographic division basis within a few months. A detailed analysis of these data is now in progress. These prices are being used as the basis for a retail price index number which will be used in determining the purchasing power of farm products and agricultural income.

HISTORICAL PRICES

The collection of prices of farm products received by producers from 1850 to 1910 is about completed for the State of Maryland. A similar project is under way in cooperation with the experiment station in Virginia.

RESEARCH IN STATISTICAL METHODS

Research work with a view to improving the quality and accuracy of forecasts made by the division has been continued. The problem of ascertaining statistically the most significant method of utilizing condition figures as a means of forecasting the final yield per acre is being given increased attention. Particular attention is being given to the possibility of using the relationship of weather to yield to supplement the condition figures as now used in making forecasts. Preliminary studies indicate that this is a very promising field for study.

COTTON DIVISION

ARTHUR W. PALMER, *in charge*

The functions of this division consist of service and regulatory work performed under the United States cotton futures and cotton standards acts, of demonstrational work, and of research work in related fields.

In the service and regulatory work no important change occurred during the past fiscal year. No formal enforcement action has been necessary under either the cotton futures act or the cotton standards act. A number of amendments to the regulations under both acts have been necessary, and revised regulations under the cotton futures act were promulgated by the Secretary, effective May 15, 1927.

An amendment to the cotton futures act was approved on February 26, 1927. This amendment eliminated from section 6 of the act the provisions under which traders on a futures exchange located at a place which was itself a bona fide spot market had been required to base their settlements for grades above and below middling delivered on future contracts upon the commercial differences prevailing in that market alone. The amendment became effective upon its approval, and henceforth the differences used in the settlement of section 5 future contracts in all markets of this country will be based upon the averages of the 10 spot markets which have been designated for that purpose.

STAPLE STANDARDS

The official staple standards of the United States have the same legal status in this country as do those for grade and color, but, unlike the latter, have never been adopted abroad. It has been felt that the conditions under which American cotton is exported would be much improved if an agreement on staple standards with the importing markets similar to the universal grade standards agreements could be reached. American agricultural and trade groups have so expressed themselves and the International Federation of Master Cotton Spinners' and Manufacturers' Associations have requested that steps in this direction be taken.

Having before him these suggestions, the Secretary invited the European cotton exchanges to send representatives to a conference in London on August 11, 1926. Owing, however, to objections on the part of the majority of the representatives from the European exchanges, no agreement was reached.

The official cotton standards of the United States for length of staple continue to be the required basis for transactions in American cotton sold in interstate and foreign commerce on standard description.

SNAP COTTON CONFERENCE

On January 10, 1927, a meeting was held in Washington between officials of this bureau and representatives of

cotton interests to discuss the problems presented by the increase in the amount of snap cotton and the certification of such cotton for delivery on future contracts. The conference, after a full discussion, gave it as the consensus of opinion that the method which has been and is now pursued by the bureau is the most practicable one at present.

"STRICT MIDDLING GRAY" MADE TENDERABLE

Trade interests have urged that the Secretary by regulation increase the number of tenderable grades under the cotton futures act by treating as tenderable certain of the so-called descriptive grades, particularly strict middling gray, middling gray, and strict low middling spotted. After due consideration, the Secretary amended the regulations to provide that, effective August 1, 1927, strict middling gray be added to the list of grades for which certificates of tenderability are issued.

UNIVERSAL STANDARDS CONFERENCE OF 1927

The regular biennial universal standards conference between the department and the nine leading cotton exchanges and associations of Europe convened in Washington March 14, 1927, for the purpose of approving copies of the universal standards for American cotton for use by the department and by the European exchanges and associations during a two-year period beginning August 1, 1927. Sixty complete sets of the universal standards were prepared and distributed in accordance with the agreements with the European associations.

PREPARATION AND DISTRIBUTION OF THE OFFICIAL COTTON STANDARDS

During the year 6,278 boxes of the standards for grade and color and 5,720 staple types were sold to the public, and $35,096.32 collected from the sale of these practical forms. Sales of loose, rejected cotton amounted to 601 bales, for which the sum of $30,862.77 was received.

CLASSIFICATION OF COTTON UNDER COTTON FUTURES ACT

All cotton intended for delivery on future contracts is classified by officers of the Department of Agriculture. The total number of bales classed for certification amounted to 422,012 compared with 339,518 for the fiscal year 1926. Reviews amounted to 93,391 bales, compared with 117,351 bales during the fiscal year 1926, and preliminary informal classification, 1,729 bales, compared with 5,246 bales the year before. The increase in the transfer of cotton to New York was quite marked; 141,054 bales were transferred to that point from New Orleans, Houston, Galveston, and Savannah. Transfers to New Orleans numbered 485 bales and to Houston 72 bales.

The increase in the number of bales tendered for delivery at Galveston necessitated the establishment on December 1, 1926, of a separate committee of the Houston-Galveston Board of Cotton Examiners in Galveston to handle the large volume of certifications.

The classification work continued to be self-supporting. Collections during the year amounted to $181,226.74; disbursements, $152,297.34. Fees charged for the service remained unchanged from the previous year, except that for supervision of the transfer of certificated cotton which, by an order of the Secretary of Agriculture, issued May 15, 1927, was increased from 20 cents to 30 cents a bale, the lower fee having been found insufficient to cover the cost of the service.

CLASSIFICATION UNDER COTTON STANDARDS ACT

In consequence of requests submitted under the cotton standards act there were issued Form A memoranda on 43,283 bales, Form B certificates on 1,212 bales, and Form C certificates on 25,083 bales. Total collections for the service under the cotton standards act amounted to $22,233.25, including the fees collected for licenses issued to classify cotton.

LICENSING OF COTTON CLASSERS

Following a decision that all licensees and applicants for licenses to classify cotton under the United States warehouse act should submit to the standard test in cotton classing, 49 applications for examinations were received during the year. A large number of the applicants under the warehouse act availed themselves of the opportunity to attend the schools in cotton classing conducted at agricultural colleges.

DEMONTRATION OF STANDARDS

Demonstrations of the standards and their use have been made during the year, and assistance has been given to a number of agricultural colleges

throughout the Cotton Belt in the conduct of cotton-classing schools. It was thought advisable to continue demonstrations of the standards to European holders and users of American cotton.

FUTURE AND SPOT MARKET INVESTIGATIONS AND COTTON PRICE QUOTATIONS

The quotations from the 10 designated spot markets are used in determining the commercial differences to be used in the settlement of future contracts made subject to section 5 of the United States cotton futures act involving the delivery of cotton of grades other than middling. Under this project differences are supervised.

Another function of this project is to obtain accurate price data on cotton and to give them wide publicity, particularly the prices of future contracts and spot cotton, in order that producers, merchants, and others interested in spot cotton may have reliable price information for their guidance. During the year the supervisory work necessary to insure accuracy and reliability in the quotations and prices from the 10 designated spot markets was continued in the same manner as previously.

Attention was directed toward gathering and disseminating information on prevailing premiums as quoted in various cotton growing and consuming districts for cotton of the character and staple commanding prices above short-staple cotton. This phase of the work is of particular interest to growers of such cottons, as it enables them to have a more accurate knowledge of the value of their cotton.

Newspapers and periodicals continued to publish information assembled by the cotton price-quotation service, but on a very much broader scale than heretofore, and cooperated in this work by publishing daily and weekly reports touching on the more vital price data which were furnished by our Washington and field offices. This service was therefore made available to a very large number of interested persons who would not otherwise have been reached. Through the medium of the branch offices, as well as through our Washington office, cotton prices and cotton-market conditions in general were broadcasted and furnished to the entire Cotton Belt. In addition to cotton quotations, the market news service carried general information pertaining to cotton and cotton marketing, which is considered of value to all interested in cotton.

STANDARD GRADES FOR COTTON LINTERS

Effective August 1, 1926, eight grades for American cotton linters were established as part of the official standards of the United States. Interest in the standard grades for linters has been increasingly active. During the year department representatives have been called to numerous meetings and conventions of the various branches of the industry for the purpose of discussing the plan of standardization and utilization of the standards. The Interstate Cotton Seed Crushers' Association, composed of producers, dealers, and consumers of linters, adopted a set of trading rules based upon the use of the standards.

COTTONSEED STUDIES

Studies of cottonseed for crushing purposes with a view to establishing standard grades have been continued. One of the first problems to be met was that of devising apparatus for obtaining representative samples of car lots of seed, since no suitable seed-sampling device was available. To meet this need, the project leader invented a simple apparatus, which has given very satisfactory results and which will be placed on the market shortly.

Analyses of samples from several thousand car lots of cottonseed have been made in an effort to determine the factor which gives the best index of the value of the seed. The analyses all show that the value differentials on account of differences of oil percentages are nominal in comparison with value differentials on account of differences of net kernel percentages. Mechanical difficulties will have to be overcome before a practical application of the theory of grading cottonseed on the net kernel content of the seed can be made. Efforts are being made in this direction.

COTTON RESEARCH FURTHER DEVELOPED AND SYSTEMATIZED

For a number of years there has been among producers and students of our cotton problems a growing realization of the need for economic research in cotton in line with a systematic and comprehensive plan.

Cotton is this country's only large agricultural product, all of which moves from the farm to market. Its value is determined from its spinning qualities, but the factors which make

up its spinning value are only partially known and understood. Without such knowledge cotton breeding, production, and marketing are handicapped. Projects for the scientific study of cotton fibers and spinning tests are expected to add vitally to present knowledge of the characteristics of cotton which give it utility. Other studies have been projected and begun in prices and quotations in local and central markets. Analyses of demand and supply are projected in studies of the grade and staple of the crop and of cotton utilization.

Although only well begun, the program has met with great interest and appreciation on the part of growers, agricultural institutions and organizations, and many branches of the industry.

COTTON-SPINNING TESTS

The cotton-testing work aims to determine the relative waste and the spinning and bleaching qualities of different grades and varieties of cotton subjected to various conditions; with information concerning quality, to assist the Bureau of Plant Industry and State experiment stations to determine from a quality standpoint the best variety of cotton to grow in certain localities; to study the effect upon spinning utility of varying the conditions of ginning, baling, compressing, and handling cotton; and to conduct manufacturing tests in connection with the study of new uses for cotton. Cooperation has been undertaken through the cotton production council of the Association of Southern Agricultural Workers with the State agricultural experiment stations, which are studying the factors affecting the quality of cotton.

The cottons which are used in the variety tests are selected through cooperation with members of the Bureau of Plant Industry, the State experiment stations, or plant breeders. A very large part of the work is conducted at Clemson College, S. C., but the final strength, length, and fiber investigations are conducted in the laboratory at Washington, D. C. Additional tests of the spinning properties of snapped and sledded cotton were undertaken during the year. The results of many of these tests have been published.

Further technical studies have been made on fiber length and strength as related to yarn strength. The results of a series of these fiber tests have been correlated with the results of the spinning tests.

Cotton growers, manufacturers, and others are expressing more interest in this work than ever before. The demand for the bulletins dealing with the various cotton problems is increasing. Inquiries regarding the methods of procedure and the results of our tests are constantly being received.

COTTON FIBER STUDIES

Special attention is being given to technological research on the physical characteristics of cotton in relation to spinning utility with a view to providing data relating the various factors of utility to the official cotton standards. Attention is being given to foreign matter, color, preparation or ginning, staple length, and character. The element of character in particular is most complex. Detailed studies of fibers are essential. In this connection some of the work that seems most likely to yield important data concerns the distribution of the different lengths of fibers in the samples, ribbon width, ribbon thickness, area of cross-section thickness of cell walls, size and shape of lumen, morphological features of the individual fiber, with special reference to the fiber tails, number and uniformity of convolutions, and strength of fibers.

Fiber color is also important, since it affects the finishing properties of yarn and goods. "Mixes" of cotton of different colors frequently result in streaks in bleached and dyed goods. Methods of color measurement and analysis are being developed for cotton. The results of this work will have direct application to some of the more complex problems of standardization.

PRICE QUOTATION AND MARKETING STUDIES

A study of prices and quotations was begun in Houston, Tex. In cooperation with State colleges and experiment stations in South Carolina, Alabama, and Texas studies have been made at selected points in those States, of the conditions under which cotton is sold in primary markets, the prices paid, and the relationship of price to quality.

COTTON UTILIZATION WORK

A comprehensive project for measuring more accurately the demand for raw cotton and for seeking new uses for it has been developed. The first problem was to learn what information was in existence on the demand

side of the cotton market and how much of it could be made available for general use. This part of the work was begun in 1926, and a summary of findings was made in the form of a preliminary report. In addition to the preliminary report already mentioned a report on the uses of cotton bags and other containers in the wholesale grocery trade has been prepared, and a study of qualities of raw cotton required in the manufacture of basic fabrics is under way.

In the field of new uses, studies of cotton bagging for cotton bales are under way which are intended to show the suitability of various designs of cotton fabrics and their relative costs.

In its study of utilization and new uses, cooperation is maintained with the Bureau of Home Economics, the Department of Commerce, and the Cotton-Textile Institute, and valuable assistance has been given by the Association of Cotton Textile Merchants of New York, American Cotton Manufacturers' Association, the National Association of Cotton Manufacturers, State associations of cotton manufacturers, and other agencies and individuals in the cotton-textile industry, as well as large associations of consumers of cotton goods, such as the American Wholesale Grocers' Association.

STUDIES OF QUALITY OF CROP AND CARRY-OVER

The Mayfield-Jones Act, approved on March 3, 1927, directs the Secretary of Agriculture to collect and publish annual statistics regarding the grades and staple lengths of the carry-over on hand on August 1 of each year, and to publish at intervals estimates of the grades and staple lengths of cotton of the then current crop. Not less than three such reports are to be published each year. Any such statistics published are to differentiate between cotton which is tenderable under the cotton futures act and that which is untenderable. Funds are not available for carrying out these provisions of the law, since the item intended for that purpose was lost with the second deficiency bill, which failed of passage. A small amount was made available in the annual appropriation act for purposes similar to those contemplated in the Mayfield-Jones Act, and some preliminary work is being done in Georgia, Texas, and Oklahoma.

COTTON-HANDLING STUDIES CONTINUED

Work in cotton tare has been continued. In addition to the tests and studies of cotton bagging as a covering for cotton bales, a study was made of the handling of cotton in Egypt. Egyptian cotton reaches the mills of this country and of Europe in excellent condition and with a tare so nearly uniform that shipments are spared the expense of "taring," which shipments from this country must frequently bear. It is thought that the report of this study, which is to be issued shortly, will contain important suggestions for the improvement of the American package.

DIVISION OF FRUITS AND VEGETABLES

F. G. ROBB, *acting in charge*

This division was under the direction of Wells A. Sherman until late in the fiscal year, when he became chief of the division of markets of the California Department of Agriculture, under a cooperative agreement between the State of California and this bureau.

MARKET NEWS SERVICE

The market news service on fruits and vegetables was continued during the year with a slight expansion of the field program, and a 14 per cent increase in the total number of mimeographed reports issued. About 10,000 names were added to the mailing lists at the 36 temporary field stations, the 17 city market stations and Washington. Approximately 13,860,000 mimeographed market reports were distributed.

Features of expansion included an enlarged use of the Associated Press service, the program in Atlanta particularly being augmented. Market reports on spring lettuce were issued at Phoenix, Ariz., for the first time in 1927. Reports on the prune market were exchanged through the clearing houses at Walla Walla, Wash., and Boise, Idaho. Steps were taken also toward establishing a somewhat similar clearing house for California grapes and some preliminary work was done on a similar plan for northwestern apples.

The bureau's leased telegraph wires continued to be a means of rapid dissemination of market news, including shipment reports, arrival and price information, and statements regarding local conditions in producing sections and terminal markets. Radiotelegraphic communication was operated between Washington and Rochester, N. Y., and Raleigh, N. C., and between San Antonio and the Rio Grande Valley.

Mimeographed summaries issued at the close of the shipping season in sections covered by temporary field stations were received with much favor and the total number of these summaries issued during the year was 51,400. The number of products included in the regular reports of car-lot unloads in terminal markets was increased just before the close of the fiscal year by the addition of pears, plums, and prunes, making a total of 19 products.

At present 34 products are included in the telegraphic shipment reports, and complete market reports are issued on only about 21 of these, not counting the special service on artichokes, broccoli, cauliflower, cherries, peas, and plums and prunes at stations on the Pacific coast. Daily shipment information is published on the remaining products.

COOPERATION OF TRANSPORTATION LINES

The volume of carload shipments reported each year has gradually increased. A total of 1,042,203 cars covering 38 products were reported by the carriers, which represents a net increase of about 63,000 over the preceding year.

Daily telegraphic reports on selected perishable products in season are received at Washington from several hundred transportation lines, these reports showing the number of cars originating in each division superintendent's territory. About 68 of these reports are known as "consolidated wires," each covering an important railroad system or major portion of such a system. Approximately 400 individual division superintendents or other reporting officials send daily wires in season.

About 15,000 local freight and express agents send monthly (station) reports by mail, covering a greater number of products than those in the daily wires. Like commodities in the two services are compared, and the discrepancies in the number of cars reported are taken up with each division superintendent.

MARKET REPORTS ON PEANUTS

Quotations have been received covering prices paid for farmers' grade stock and selling prices for shelled and unshelled peanuts, peanut oil, and peanut meal or cake. Supplementary information on prevailing prices in the producing areas has been obtained from peanut brokers in the large consuming centers. Weekly telegrams have been received from the bureau's branch offices covering car-lot arrivals and boat receipts during the preceding week, market conditions, and selling prices or quotations in large lots of both cleaned and shelled peanuts. Records of peanut shipments have been obtained through the agents of the different railroads and boat lines serving the Virginia-North Carolina, and southeastern and the southwestern producing areas. Weekly telegrams are received from bureau representatives in San Francisco and Seattle, covering market conditions and prices of Chinese peanuts, f. o. b. Pacific coast points, and the importations of peanuts and peanut oil at those cities. Through the Bureau of Foreign and Domestic Commerce, detailed import and export statistics have been secured for these products and published once a month.

MARKET REPORTS ON HONEY AND BEESWAX

At present 110 large beekeepers and honey shippers, scattered throughout the country, furnish reports of market prices, conditions of colonies, and honey plants, etc., that are combined for publication in the honey-market news reports. Representatives in the bureau's branch offices also wire semimonthly reports of the market conditions and prices.

UNLOAD REPORTS FROM PRINCIPAL MARKETS

Regular, periodical reports of unloads of important fruits and vegetables are received from 66 cities. Representatives of the bureau in 25 markets and railroad agents in 41 other markets furnish the unload reports covering 19 important fruits and vegetables. These reports of unloads of car-lot shipments are secured each day from the railroads and express companies. Similar reports are received from important boat lines. This information is tabulated and submitted to the Washington office in monthly summary form.

Much of the unload information has been prepared in condensed form and these tabulations have been mimeographed to supply the increasing demand for such data on the part of growers, shippers, members of the trade, transportation officials, schools, and colleges. The figures also are used in summaries of the shipping seasons

in producing sections and in other reviews. The data are of great value because they show the monthly and annual receipts of various products in large consuming centers, as well as the sources of supply. The bureau's representatives in various markets frequently prepare press releases or mimeographed statements for public distribution on the basis of these figures.

REVIEWS, SUMMARIES, AND SPECIAL REPORTS

A corps of four or five employees maintains current tabulations of market prices and conditions for all the leading markets and shipping points, prepares special reviews and summaries based largely on these statistics, writes articles for trade papers and farm journals, and handles a large correspondence on miscellaneous marketing problems.

The weekly summary of car-lot shipments is mimeographed and distributed each Tuesday to about 960 persons, in addition to being duplicated and distributed in part from the various market and field stations. This publication summarizes in comparative columns the car-lot shipments of the principal fruits and vegetables as reported telegraphically by the carriers each day.

Further developments have been made in the line of special monthly or weekly reviews for particular papers, chiefly farm journals, in different parts of the country. A monthly market review, issued to some 80 subscribers on the 15th of each month, tells of the market trends during the preceding four weeks, in addition to outlining future prospects.

Early in the fiscal year, a new series of special commodity summaries was begun, and these have met with much favor. Several pages of text are combined with statistical tables relating to acreage, production, shipments, unloads, prices, etc., so as to bring together the several lines of material affecting the market position of a particular product at the height of the season. These commodity summaries usually are released long enough in advance of the peak movement to be a guide in the marketing of the crop, and effort is made to indicate the crop outlook. Two summaries are issued each month, particularly for the trade and the press.

In addition to these special releases devoted strictly to fruits and vegetables, combination reviews are written, which summarize the market conditions for cotton, grain, hay, livestock, meats, poultry products, butter, cheese, wool, etc., along with a summary of the fruit and vegetable situation. All of these special reviews obtain a very wide circulation, because they appear in some of the best-known farm journals.

The fruit and vegetable section of the weekly Marketgram summarizes the latest developments of the preceding seven-day period and describes important changes in market prices and conditions.

The monthly issues of the department's paper, Crops and Markets, contains several pages of statistical material relating to fruits and vegetables. One table shows car-lot shipments by States and by products, and another table gives a monthly range of jobbing prices of the leading products in several important markets.

Special reports by mail, messenger, and telegraph are prepared for certain newspapers and farm journals that have requested this service. These reports, some of them daily and others weekly, summarize the market situation on selected products and are published regularly by the respective papers.

Considerable work is done in Washington and at various branch offices through the Associated Press and similar services. Work at Atlanta has been developed particularly, and, during the five months when leased-wire service to Atlanta is discontinued, the Washington office prepares a daily report on southern products, which is transmitted by Associated Press wires to the Atlanta office.

After the close of each temporary field station of the market news service, the local representative writes a summary of the daily information that was published during the period of operation, together with a general review of the marketing season in that territory. This summary in the hands of farmers points out the successes and failures of the past season, and serves as a guide in the planting, harvesting, and marketing of the crops of the following seasons.

STATE COOPERATION IN MARKET NEWS WORK

Cooperative market news work has been continued in 20 States. The assistance given by the various States has made it possible to give a much more complete service than would otherwise be possible. In 6 of these States the fruit and vegetable work has been incidental to a general market news program, but in the other 14

States specific fruit and vegetable work has been provided for. In many sections, State representatives aid in obtaining information relative to prices and conditions in producing districts and their assistance in all cases has resulted in a wider distribution of the market information.

A rather definite policy has been established that no additional field stations shall be opened except where local or State financial assistance can be given, up to approximately half the cost of operation. During the early part of 1927, it was possible, on this basis, to give a service on spring lettuce from a field station at Phoenix, Ariz.

CLEARING HOUSE FOR NORTHWESTERN PRUNES

At the request of the Shippers' Traffic Association at Walla Walla, Wash., a representative of the new service was stationed in the Walla Walla-Milton-Freewater prune district, to aid in the marketing of the fresh prune crop. This region had had difficulty in previous years in the marketing of this crop, and during 1926 devised what was known as the "Walla Walla plan," which included the operation of a clearing house for market information for the prune growers and shippers. The shippers, who handled nearly 95 per cent of the output, each day advised the Government representative of their quotation, sales, primary destinations of shipments, diverted cars, rejections and allowances, cancellation of orders, etc. This information was then compiled and issued in the form of a consolidated report to all of the cooperators, and their accounts were later checked to verify the accuracy of the reports. This daily exchange of information through an official agency tended to stabilize the market, create a feeling of mutual confidence among the shippers, improve distribution, and prevent the overloading of any of the consuming centers. Faced with strong competition from the heavy crops in the East, this plan of marketing northwestern prunes is believed to have averted the disasters experienced in previous years and to have aided the growers in getting fair returns.

The clearing house for California grapes to be in effect during the fiscal year beginning July 1, 1927, will be operated on lines very much like those for northwestern prunes, the greater importance of the grape crop simply emphasizing the need for a clearing-house plan.

STANDARDIZATION WORK PROGRESSES

A gratifying impetus is given to national standardization by the adoption of various grades as official State standards. Twenty-seven States have now officially adopted one or more of the United States standards.

With the exception of a few commodities such as California citrus fruits and northwestern apples, the United States standards for fruits and vegetables are generally recognized by the trade as their commercial standards. The food products inspection service has been largely responsible for introducing new standards and extending the use of our old ones. National standardization of fruits and vegetables would no doubt still be in its infancy were it not for the work done by this service. The research relating to the promulgation and use of standards entails obtaining data upon which to base standards for new commodities and also for the purpose of revising old specifications. Very satisfactory progress has been made during the past year, standards for 37 commodities having now been recommended.

This project works in close cooperation with the inspection service. Considerable time has been spent with the inspectors at both shipping point and receiving markets in assisting with interpretation of grades and securing information for the revision of old grades. Photographs of grade defects of fruits and vegetables are being prepared and placed in the hands of inspectors to aid in securing a more uniform interpretation of the United States standards. Word descriptions are often inadequate to describe the degree of damage which is permitted in any particular grade, and in many cases photographs are proving extremely valuable.

RESEARCH STUDIES

This bureau is cooperating with State agencies to make a national survey of the apple industry. This division is aiding in this study by furnishing an employee to obtain and compile data relating to distribution, prices, methods of sale, and selling costs. Market news men and inspectors in the city markets are also aiding in the survey by interviewing the trade to obtain market information.

A statistical study of the commercial strawberry industry is being made to show the areas of production, carlot distribution from States of origin, and market supply of 69 of the larger cities. Statistical tables of acreage,

yield per acre, production, shipments, and unloads are being compiled in such a manner as to display the principal relations of each to the others and to the whole. This study will furnish information which should be of great aid to those interested in gaining a better understanding of the marketing conditions of the strawberry industry.

This division assisted the Division of Agricultural Cooperation in a study of market preferences for Washington-Oregon prunes existing among the jobbing and retail trade in several important primary markets.

In cooperation with another division of the bureau, a marketing specialist on fruits and vegetables has been maintained at London visiting the fruit and vegetable markets in Great Britain, Irish Free State, France, Holland, Germany, Denmark, Norway, and Sweden. European competition and demand for apples, pears, oranges, grapefruit, and fresh prunes were reported upon. A special service was rendered to producers and exporters by observations of the marketing specialist concerning the condition of American fruits arriving in Europe and its relation to grading, packing, and shipping methods. Research work was done also in determining European demands respecting specifications for apple standards.

During the apple-marketing season a London circular was issued biweekly and forwarded to European agents, distributors of American fruits, giving them information on fruit grades, inspection service, crop conditions, movement, and prices in the United States. This service is very popular with the smaller wholesale merchants and agents who are but very inadequately informed by their shipping connections on facts requisite to intelligent merchandising of American fruits. During the months of June, July, and August of each year the marketing specialist has returned from the foreign station and visited growers and shippers in districts producing exportable fruits, addressing meetings on problems attending the foreign marketing of their products.

CONTINUED GROWTH IN INSPECTION SERVICE

Both receiving and shipping-point inspection of fruits and vegetables have been conducted on the same basis as during the two previous years. Receiving-point inspection showed a slight increase of 263 cars, while shipping-point inspections showed an increase of 27,968 cars. This increase has been generally well distributed among the various States, although in a few States there was a slight decrease in the work.

RECEIVING-POINT INSPECTIONS

Offices were maintained in 40 cities. From these offices inspections were made, to the extent permitted by the time of the inspectors, at other near-by points from which requests were received.

A total of 32,794 cars of fruits and vegetables were inspected at receiving points, and in addition more than 8,000,000 pounds of fruits and vegetables and other foodstuffs were inspected for the steamship lines.

Developments in connection with the apple-export situation made it necessary during the past season to issue different colored certificates which were designed to show the freedom from spray residue of apples intended for export. The requirements in this regard have been more strict and in addition to requiring apples to be free from residue on the surface they were also required to be free from heavy or crusted residue in the stem or blossom-end basins. Slight or inconspicuous spray residue was passed for export.

The regular certificates (white original and blue copies) were issued on all unrestricted inspections of apples that met the export requirements, that is, free from conspicuous spray residue. On all lots which did not meet these requirements a yellow certificate was used both at point of origin and in the receiving markets. In the terminal markets the yellow certificates were also used on restricted inspections and all inspections of apples which were not free from conspicuous spray residue.

In the case of pears a chemical analysis was required in order to determine whether the amount of arsenic exceeded the tolerance or not. Samples drawn by food-products inspectors were taken to chemists, who had been approved by the Bureau of Chemistry, and their analyses were also reviewed by that bureau. When the amount of arsenic exceeded 0.01 grain per pound of fruit the yellow certificate was issued, and the shipment was not acceptable to the steamship companies for export.

AUCTION INSPECTIONS

Beginning August, 1926, and continuing until the end of the grape season, a new line of auction inspection work was started in Chicago. Inspec-

tions had been made in previous seasons of grapes, cantaloupes, and other products to be sold through the f. o. b. auctions, but the grape-inspection work in Chicago was the first undertaken in connection with produce to be sold through a delivered auction. The agreement which was entered into with a large fruit-auction company provided for the inspection for condition only of all car lots of California juice grapes offered for sale by this company in Chicago. A total of 1,129 cars was inspected under the terms of this agreement. A written report, giving the results of the inspection, was tacked on the side of each car prior to the daily auction sales. The buyers also had the opportunity to examine the samples themselves before the sales started. Both the buyers and the auction companies expressed their approval of the service rendered by the Federal inspectors, who exercised great care in selecting samples that fairly represented the quality and condition of the contents of the cars from which samples were taken.

RAILROAD INSPECTIONS

The railroad work in Cleveland, Ohio, which was conducted under a special contract with a railroad company, has continued steadily throughout the year, a total of 5,271 inspections having been made. When this service was first started two men were sufficient to handle the work, but toward the close of the fiscal year it was necessary to keep a force of four men available for this work. A special feature of the work has been the keeping of records showing the number of broken packages per car. A great many claims were filed against the carrier on account of broken packages and damages to their contents, and the railroad officials, as well as receivers, have informed this bureau that its services in this respect have been of great assistance in settling claims with fairness to both sides.

INCREASING DEMAND FOR SHIPPING-POINT INSPECTIONS

The fifth year of operation of the shipping-point inspection service continues to demonstrate the fact that this service is of benefit both to producers and shippers, as it furnishes them an unbiased report on the quality and condition of their products which facilitates the marketing of their goods and safeguards their interests in cases of damage or disputes.

The service has also served as an educational agency and has been very effective in promoting the use of uniform standards and improved methods of preparing products for market.

A total of 193,220 cars of fruits and vegetables were inspected at shipping points located throughout 40 States. This was an increase of 27,968 cars over the number inspected during the previous year. Florida showed the greatest increase of any State, the increase being 6,157 cars. Practically all of this work was done under cooperative agreements in the various States.

ENFORCEMENT UNITED STATES STANDARD CONTAINER ACT

The work under the standard container act has increased greatly. During the past year a total of 6,605 containers have been tested compared to 2,571 during the preceding year. Marked changes have taken place in the package industry and this division has had great difficulty in meeting the demands made upon it for consultation and checking of specifications. Representatives have attended meetings of package manufacturers and carried on as much educational work as time permitted.

COLLECTION AND DISTRIBUTION OF 1918 EXCESS WOOL PROFITS

Pursuing the policy decided upon a year ago of suspending action in excess-wool profits cases pending in district Federal courts to await a decision by the Supreme Court as to the right of the Government to collect excess-wool profits under the 1918 wool regulations issued by the War Industries Board and subsequent agricultural appropriations acts, little progress has been made during the fiscal year 1927 in closing out this work. The work will be held in abeyance until a final decision is handed down.

The activities of the domestic wool section have been confined principally to the auditing of additional reports received from wool dealers in 1918, perfecting the audits of cases awaiting trial and distributing excess profits amountaing to $1,695.84 among the wool growers on whose wool the excess profits were made. During the year $2,421.09 additional excess profits were collected from dealers. The total ascertained excess profits made on wool of the 1918 clip amounts to $1,510,227.18; the amount collected to date amounts to $758,940.51, and the total amount refunded to growers amounts to $452,927.44.

DIVISION OF LIVESTOCK, MEATS, AND WOOL

CHARLES V. WHALIN, *in charge*

The past year witnessed the attainment of several of the objectives which this division had set as goals to be reached in carrying out its long-time program of research, service, and educational work. Much progress was made in the establishment of standards for livestock and meats. Bulletins carrying descriptions of some of the standards were published and public interest in the division's efforts along this line was aroused to a much greater extent than ever before. This interest was reflected both in increasing demands for the division's grading service on the part of governmental and commercial institutions which purchase meat in large quantities and in increasing requests for information on standardization from producers, consumers, dealers, and others who are interested in the livestock and meat industries.

The progress made by the division in analyzing and interpreting market statistics has been particularly gratifying. This work serves as the basis for livestock outlook reports and intelligent livestock marketing and there is an increasing demand for information based on the division's studies in this field.

The service work of the division both in market news and meat grading was materially expanded and made more complete through various refinements in organization and methods. This work has been developed to the point where it is now an important factor in the nation's commercial life. An experimental meat grading and stamping service has been developed.

In the field of educational demonstrations notable progress has been made in bringing to the attention of livestock producers information regarding consumer demands, market requirements, and the advantages of grade standardization. The rseponse on the part of the public to the division's efforts indicate that there is an urgent demand for more information about marketing and the problems connected therewith.

GRADE STANDARDIZATION

Public attention was drawn to the division's standardization work during the past year and great numbers of livestock producers and meat consumers expressed interest in this work. A new organization of livestock producers was formed, having for its sole object the advancement of one of the important aspects of the division's standardization program. Not only livestock and meat-trade journals but the public press in general devoted a large amount of space to explaining, discussing, and advertising this work.

LIVESTOCK AND MEATS

An outstanding item of research along standardization lines was the work which for the past two years has been conducted under the Purnell act in cooperation with the Bureau of Animal Industry, Bureau of Home Economics, National Livestock and Meat Board, and a large number of agricultural colleges and experiment stations scattered throughout the United States. The stated purpose of this work is "determination of the factors which make quality in meat," but as an incident to the study many data are gathered which are of value in establishing a scientific basis for grade standards. In the prosecution of this study within the past fiscal year 1,000 cattle and 400 lambs were graded—first as feeders, later as slaughter animals, and finally as dressed carcasses. More than 125 cuts of beef and a like number of cuts of dressed lamb were physically and chemically analyzed, cooked, and again graded for color, flavor, tenderness, juiciness, and general palatability.

Although no standards were officially promulgated during the year three sets of such standards were prepared, and it is hoped that all of them will be formally promulgated by the Secretary early in the current fiscal year. The list includes grade standards for five classes of slaughter cattle, grade standards for vealers and calves, and grade standards for veal and calf carcasses. Work has been done also on the formulation of grade standards for lambs, yearling sheep, and mature sheep, and also for dressed lamb, yearling mutton, and mature mutton carcasses.

In addition to these formal grade standards, manuscripts for a scientific bulletin entitled "Market Classes and Grades of Vealers and Calves," and a circular entitled "Twelve Talks on Grade Standards for Livestock and Meat" were prepared.

WOOL

Following the promulgation of official standards for grades of wool and wool top based on the numerical system there has been an active demand

for sets of the practical forms of the standards, and 111 complete and 148 partial sets for wool and 137 sets for wool top were prepared.

Establishment of official standards for wool and wool top provides a basis upon which to effect improvement in wool-marketing methods and a better realization of this fact is becoming more apparent among those who are striving to assist producers, as indicated by the increasing demand for sets of the practical forms. These sets are used in connection with educational demonstrations in wool grading and marketing.

A resolution approving the division's wool standards and recommending that they be used by South American countries was adopted by the Pan American Standardization Conference held in Washington under the auspices of the Inter American High Commission. Requests for sets of the standards have been received from government officials of South Africa and inquiries regarding them have been received from several European countries.

Assistance was rendered to the North Dakota Agricultural College in connection with a study of the inheritance characteristics of sheep from a wool-quality standpoint by classifying 285 samples of wool submitted.

In cooperation with the Utah Agricultural College studies were made to determine the density and uniformity of quality of fleeces obtained from sheep representing different range flocks.

HIDES AND SKINS

Late in the fiscal year the division appointed a hide-marketing specialist with a view to developing standard grades for hides and skins. Preliminary surveys of existing conditions in the hide and skin industry have been made and several conferences have been held with leading representatives of the various industries which use these products in one form or another. A tentative classification has been drawn up and this will be used as a basis for further studies and investigations.

METHODS AND PRACTICES OF MARKETING

Continued attention was given to the collection of data bearing on the direct buying of hogs. Part of the information was used in the preparation of a paper presented before the American Institute of Cooperation entitled "Shifts in Corn and Hog Production and their Relation to Livestock Markets and the Packing Industry."

In cooperation with the Virginia Agricultural Experiment Station further studies were made of the problems of marketing Virginia beef cattle by following selected shipments through the market and slaughtering plants. The results of the study were incorporated in the manuscript dealing with this problem which was prepared in the previous year and has since been revised.

STATISTICAL RESEARCH

Increasing demands for information regarding price and production trends, consuming demand, market movements, and other factors which would be helpful to livestock producers and others in formulating their production and marketing plans has caused the division to give more attention to the analysis and interpretation of the economic information assembled by its market-reporting staff. The results of the studies made in this field serve as the basis for the semiannual livestock outlook reports and the reviews and special reports dealing with the livestock and meat situation released from time to time. The statistical material assembled in the division includes daily livestock prices by 61 classes and grades at 22 important livestock markets; daily fresh meat prices by 30 classes and grades at 4 markets; prices of cured meats and wool, actual receipts of the various classes of livestock at 18 markets, and many additional data.

Many of the results of the division's statistical research were made available to the public in the form of press articles, reports, addresses, summaries, and reviews, all of which served to give more complete information regarding the economic situation in the livestock, meat, and wool industries.

Progress was made in the analysis of the factors which affect the price of beef cattle. The results of this study will be summarized for publication in the near future.

A study of the daily distribution of livestock receipts at the larger public markets during 1926 was made with a view to determining whether there was unnecessary bunching of receipts on certain days of the week and whether such distribution tended to affect the stability of the market and was uneconomical. Expressions on the subject were obtained from a large number of representatives of producers and the various agencies involved in the marketing and transportation

of livestock. A statistical analysis of the distribution of receipts was also made and recommendations were published for the purpose of bringing about a better distribution of market receipts of livestock.

PUREBRED LIVESTOCK PRICE SURVEY

The purebred livestock price survey was continued and printed schedules were sent to 42,000 breeders with the request that they report on the number of purebred animals sold at auction and private sales according to breed, sex, and age.

The survey for 1926 showed further improvement in the purebred livestock industry and that a better demand existed for breeding stock. The publication of price information based on a large percentage of the total transactions serves as a reliable guide to actual values of purebred stock and is an important factor in stabilizing the industry.

MARKET NEWS SERVICE

The market news service on livestock, meats, and wool was maintained along the usual lines, the objective being to supply producers, distributors, and others as quickly as possible with complete, accurate, and timely information regarding supplies, demand, prices, and general developments in the various market centers.

The most important development in the news service during the year was its expansion to include the livestock markets at Pittsburgh, Buffalo, Cleveland, Cincinnati, Indianapolis, and South St. Joseph. This expansion was made possible through a small increase in the appropriation allotted for the service, and through cooperative arrangements effected with State departments of agriculture and trade interests. As a result of this expansion the division now operates 22 field offices, and supervises the reporting of 30 public markets. While the funds do not permit furnishing as complete a service as is desired at the new offices, advantage was taken of every local facility and opportunity to provide the best service possible to the patrons of those markets. This was done by preparing special reports for publication in the local press and for dissemination by radio and telegraph. In several instances local commission agencies mimeographed the division's reports and mailed copies to their patrons.

IMPROVEMENTS IN THE SERVICE

In order that producers and shippers might have available all information which would be helpful in planning their market operations, considerable elaboration and refinement was made in the regular reports released the previous year, and the service was broadened by additional reports, prepared for dissemination by radio and the press. Through the combined media of these two agencies the service is now easily and promptly available to everyone.

The radio has developed into an important agency in the dissemination of market news. Reports from all but two markets at which the news service is maintained are being broadcast by one or more stations, and are being received by many thousands who are interested in livestock, meat, and wool markets. Information at hand shows that at least 55 radio stations, including the most powerful in the country, are making use of the division's reports.

In an effort to obtain the widest possible dissemination of its reports at a minimum of expense to the bureau, the division has continuously sought the assistance of the press. There are now few daily or weekly newspapers located in livestock-producing sections of the country that do not utilize to a greater or lesser degree the division's market news, while practically all of the daily general and commercial newspapers published in the larger cities of the country and a large number of trade papers and agricultural publications are utilizing the service.

The Associated Press was one of the first news agencies to make use of the division's reports, and it is now transmitting these reports on all its trunk lines and on all of its subsidiary and State wire circuits that serve sections of the country where livestock is produced to any appreciable extent. Newspapers with a combined daily circulation running well into the millions now carry the division's reports as disseminated by this agency. The United Press Association also is handling the service on its telegraphic circuits, receiving and disseminating reports from nearly all branch offices, and through the newspapers it serves is making the reports available to additional millions of readers. Increasing use of the service also is being made by the International News Service, which serves a large number of newspapers.

No material changes were made in the form of the daily reports supplied the Western Union and Postal Telegraph companies for their CND (commercial news dispatch) services. How-

ever, the opening of the six new field stations of the division made possible the greater use of these efficient news-disseminating agencies than previously. Shortly after the establishment of the livestock market news service at Chicago in 1918 the division was called upon to prepare the livestock CND reports of the Chicago market. The official character and reliability of the reports supplied prompted officials of the commercial wire companies to request the division to assume the responsibility for the preparation of these reports at all markets where the division maintained a reporting staff. Much attention has been given by the division in past years to this service, not only with regard to the accuracy of the reports supplied but also with regard to their form, content, and filing hours, with the result that, notwithstanding the development of the radio as a means of prompt and widespread dissemination of market news, patronage of the CND service has increased and the service has been improved in all essential respects.

During the past year the number of mimeographed reports released was somewhat in excess of the 5,000,000 distributed the year previous. The number distributed to individuals, however, remained practically unchanged, the increase being reports mailed to bankers, newspapers with rural circulation, and to other commercial concerns which in turn posted or published them. Through this method the number having access to all of the detailed information carried in the mail reports has been materially increased without corresponding increases in the names on the mailing lists.

One regular report not previously released was added to the list of mimeographed releases during the year, a special daily grass-cattle market report, covering the larger midwestern markets and released from the Denver, Salt Lake City, San Francisco, Wichita, and Fort Worth offices during the main grass-cattle shipping season from July 1 to November 1. Another feature of the mimeograph report service added during the year was a weekly report of hogs slaughtered under Federal inspection at eight important slaughtering centers. This information, now released in conjunction with the daily livestock market summaries on Saturday of each week, carries the totals for each of the eight markets for a seven-day period ending the day previous. The Bureau of Animal Industry is cooperating in this service.

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Advance and early morning estimates of livestock receipts continued to prove an important feature of the market news service at the major markets. There is perhaps no one feature of the service which attracts as much general interest on the part of the trade as this, especially as confidence increases in the advance estimate being a correct indication of shippers' intentions.

DEMONSTRATION AND EXHIBITS

One man devoted most of his time during the year to giving actual demonstrations of the division's livestock grade standards in the important livestock-producing sections of the country. He gave demonstrations at 100 meetings at which the estimated total attendance was 40,000 persons, largely stockmen, county agents, and others interested in learning what the department is doing along standardization lines. The extension service of the department and that of a number of the States cooperated fully in these demonstrations. In many instances the grade demonstrations were conducted right on the farm or ranch, the stockman's own animals being used for the purpose.

In addition to these special grade demonstrations the division contributed to general bureau and department exhibits and assisted various agricultural colleges and State institutions in putting on livestock and meat-grade exhibits. The division's market representatives also took advantage of many opportunities for carrying on educational work, both directly and indirectly. In cooperation with trade interests at certain market centers demonstrations of the standard classes and grades of livestock, meats, and wool were made at a number of important meetings of trade interests and producers. Many addresses were made at association meetings and conventions.

MEAT GRADING AND STAMPING SERVICE

A feature of the service work of the division during the past year was the beef-stamping project which was begun on May 2. Although the division has been grading meat on a commercial scale for the past three years—the New York office alone grading more than a million pounds per month on an average—nevertheless, little if any of this meat was stamped.

An organization known as the Better Beef Association was organized during the year through the efforts of several editors and cattle breeders.

The purpose of the association was to popularize among the consuming public the higher grades of beef, and one of the means used to accomplish this was to so stamp a carcass or wholesale cut that the class and grade would be easily distinguishable even in a retail cut.

To bring about this situation the cooperation of the packers, the National Livestock and Meat Board, and this division was solicited and obtained. A roller stamp was devised suitable for the purpose, and on May 2 a corps of official beef graders began grading and stamping prime and choice grade beef. The service was started experimentally in nine cities—Boston, New York, Philadelphia, Washington, Chicago, Sioux City, Omaha, St. Joseph, and Kansas City.

The work was undertaken for the purpose of determining whether the beef consumers of the country really demand Government certification of grade. Notwithstanding the fact that the service is new, is on a wholly permissive or request basis, and the further fact that the stamping is limited to the two upper grades—choice and prime—a total of 8,214 carcasses, approximating 4,125,000 pounds of beef, was graded and stamped during the first two months of the experiment. The number of carcasses graded and stamped has increased steadily from week to week, and there seems to be good reason for believing that the service is appreciated not only by beef consumers but by most members of the trade who have availed themselves of it. During the time that the service has been in effect there has developed an insistent demand that it be extended to include good-grade steer and heifer beef. Resolutions to this effect were passed by the Kansas State Retail Meat Dealers Association, the Illinois Retail Meat Dealers Association, the New York Retail Meat Dealers, and the National Livestock and Meat Board.

The regular meat-grading service for such institutions as the United States Lines and affiliated steamship companies, the United States Veterans' Bureau, State institutions, and many retail meat dealers has been conducted as in the past except on a constantly increasing scale. Recently a grader has been stationed at New Orleans to provide such service at a number of Gulf ports.

OPERATION OF CENTER MARKET

C. H. WALLEIGH, *superintendent*

The operation of Center Market was under the direction of C. W. Kitchen until January 1, 1927, when he became assistant chief of the bureau.

The policy prevailing in previous years regarding the management and control of the market was continued. Special attention was given to sanitation, as well as to the appearance of the market, attractive arrangement of merchandise, and convenience to the public. Six modern refrigerated counters for the display of dairy products were installed. These will furnish an opportunity for experimental work in testing the practicability of the use of such equipment. Necessary repairs and alterations have been made from time to time, and improvements have been effected in the cold-storage department, which will effect a saving of $1,000 per annum in operating expenses. It has also been possible to manufacture and sell a larger amount of ice than in former years.

Financial reports from all the stand holders within the market were required as usual. These reports showed gross sales of $9,661,030.57 (exclusive of the farmers' line and wholesale row). The volume of business done as well as the expense incurred in its conduct was shown.

GRAIN DIVISION

H. J. BESLEY, *in charge*

The work of the grain division is divided into two parts, (1) enforcement of the United States grain standards act, and (2) research studies.

The work is directed from the Washington office and through the general field headquarters, Chicago, and the Pacific coast field headquarters at Portland, Oreg. There are 4 division supervisors and 33 district offices of Federal grain supervision. Official standards for shelled corn, wheat, oats, feed oats, mixed feed oats, rye, grain sorghums, and barley were in effect during the fiscal year. In connection with the division's responsibility in connection with the food and drugs act as it applies to grain it became necessary to assign a man to the staff of the general field headquarters to handle the work.

BARLEY STANDARDS REVISED

The standards for barley were new, becoming effective in August, 1926, and certain revisions were found desirable. The barley from the Northwest was abnormally wet, on account of wet weather, and failed to meet the specifications with respect to moisture content. This difficulty was most pronounced in connection with the expor-

tation of barley through Atlantic seaboard ports, principally New York.

In the case of California barley difficulty was experienced in merchandising barley in export because of the practice of exporting barley from California on the basis of San Francisco Chamber of Commerce types. The barley standards operated fairly well in California so far as domestic trade was concerned.

Pursuant to requests from the trade, changes were made in the standards for eastern barley by raising the moisture content from 14.5 to 15.5 per cent in the case of grades Nos. 2, 3, 4, and No. 1 feed barley, and an adjustment in grades 2 and 3 of the requirement for sound barley involving an allowance of 10 per cent of oats in these grades instead of 8 per cent as previously permitted. In the case of western barley the standards were changed so as to provide that the determination of smut in barley be made on the basis of the grain including dockage.

CONFERENCES HELD WITH EUROPEAN BUYERS

In connection with problems arising out of administration of the grain standards act, the division leader and a representative of the Bureau of Plant Industry, visited European points. The problems which necessitated this trip were: (1) Complaints registered with this department by the London Corn Trade Association and the Liverpool Corn Trade Association against the inspection of United States grown grain by Canadian Government inspectors at Montreal in cases where such grain was shipped from the port of Montreal in foreign commerce; (2) the problems which have arisen in connection with the exportation of eastern barley through Atlantic seaboard ports on the basis of the new standards for barley which became effective in August, 1926; and (3) problems arising out of the new barley standards as they affected the California crop, with respect to the exportation of brewing barley from San Francisco to consuming markets abroad.

Conferences were held with the Liverpool Corn Trade Association and the London Corn Trade Association and others. It was made clear at these conferences that the United States Government had no jurisdiction over the inspection of grain at Montreal and that complaints against inspections at that port should be properly referred to the Canadian Government. A survey was made of the needs and requirements on the part of European buyers for barley to be used for malting and brewing purposes. In addition a full explanation was made to buyers of eastern barley as to the intent of this department to change its standards for barley, which changes have since been made.

INCREASE IN NUMBER OF APPEALS

The appeal service under the act has been utilized by producers, shippers, and receivers of grain to a greater extent this year than ever before. More than 60,000 appeals were handled in the offices of Federal grain supervision throughout the country, and of this number 1,335 went to board appeal before the boards of review at Chicago and Portland.

Here it should be noted that cargo loadings frequently covering from 300,000 to 400,000 bushels of grain are recorded as a single appeal if the grain is offered as a single inspection lot. Many such cases occurred in the lake loadings during the year.

This demand for Federal service was no doubt occasioned by a desire for final Government determination of grade and the fact that the wheat and corn crops in certain sections presented many difficult grading problems, a large amount of low grade and damaged grain being offered. Fifty-seven per cent of the appeals called were not sustained, and the fees collected in these cases amounted to $70,851.49, which sum was covered into the Treasury as miscellaneous receipts.

LICENSED INSPECTORS AND INSPECTION POINTS

At the close of the fiscal year there were 130 regular inspection points and 24 additional points which were covered. There were 456 licensed inspectors. It was necessary to take disciplinary action against 7 licensees on account of misgrading of grain or other violation of the regulations.

MILLING AND BAKING STUDIES

Tests were made on samples of commercial wheats for the purpose of checking milling and baking qualities against the grade assigned by licensed grain inspectors and federal grain supervisors under the provisions of the United States grain standards act. Milling and baking tests were made on 298 wheat samples for the Office of Cereal Investigations, Bureau of Plant Industry, in connection with the development of new wheat varieties hav-

ing superior milling and baking qualities.

Tests were also made for other branches of the department. Approximately 600 samples of wheat from foreign countries representing the principal varieties grown in 33 of the principal wheat-producing countries of the world and 331 samples of commercial wheats from nine exporting countries, which arrived at 15 foreign seaports, were tested for milling and baking qualities for the purpose of comparison with American wheats.

In order that the various types and qualities of wheat produced may be marketed and utilized to the best advantage, a great many studies and experiments have been conducted. A study was made of the types of flour used by the trade for the manufacture of pretzels. Experiments were conducted in order to determine the suitability of certain various types of flour for this purpose. A manuscript containing the results of this study has been prepared and submitted for publication as a technical bulletin.

Cooperation was extended to the American Association of Cereal Chemists in their efforts to standardize the experimental baking procedure.

Correlation studies of kernel texture, test weight per bushel, and protein content for hard red spring wheat were made and the information obtained was prepared for publication in the Journal of Agricultural Research. A knowledge of these relationships will aid in a better understanding of the relative value of each of these factors in connection with the marketing of wheat.

Studies were also completed and bulletins published on the relation of kernel texture to the physical characteristics, milling and baking qualities, and chemical composition of wheat, and on the influence of granulation on chemical composition and baking quality of flour.

INFLUENCE OF GARLIC STUDIED

Wheat is discriminated against in the markets if an odor of garlic is present. For this reason, preliminary studies have been made of the moisture, oil, and sulphur content of garlic in preparation for an extensive study of the influence of garlic on the milling and baking quality of wheat.

CHEMICAL AND LABORATORY TESTS

The rapid oil test previously developed for grading flaxseed was further studied and the technic developed so that the test is now applicable to a large variety of products. A study was made of the chemical composition, particularly of the protein content, of a large number of samples of American and foreign-grown wheats. Studies were also started to determine the factors which can be used in grain inspection and in grain handling to determine when wheat is "sick" and unfit for milling and baking experiments and tests, and numerous bulletins were prepared for publication.

RICE STANDARDS REVISED

The United States grades for milled rice and for rough rice were revised and each set of revised grades was published in handbook form. Both sets of grades as revised have been adopted by rice-trade associations and rice-inspection departments for commercial use. Investigations pertaining to the standardization of grades for brown rice were continued, and considerable progress was made in this work.

A new rice-investigation office was opened in San Francisco at which point close cooperation was maintained with the California State Department of Agriculture in connection with their rice standardization and rice grading work. Assistance was given rice mills and rice dealers in the establishment and operation of rice testing and grading laboratories. Lectures and demonstrations pertaining to methods for grading rice and to improved methods for handling rice were given in the new rice territory of Missouri and in the rice sections of Arkansas. Numerous articles pertaining to improved methods of handling rice were prepared which were published in various newspapers and farm and rice-trade journals.

METHODS PERFECTED FOR DOCKAGE DETERMINATIONS

Investigations and experiments were conducted with a view to perfecting the method of making "dockage" determinations in connection with the grading of wheat and rye under the provisions of the grain standards act. Various makes of dockage-testing machines found on the market and used by licensed grain inspectors were tested for comparative results. A new method was developed for testing the accuracy of the equipment used by grain inspectors for determining dockage in grain.

GRAIN-CLEANING WORK EFFECTS SAVINGS

Investigations and experiments relative to cleaning grain and rice on the farm and at country elevators were conducted in the spring wheat area and on the Pacific coast. The data obtained in these investigations show that the weed seeds (dockage) which were raised and threshed with the wheat in the four principal spring wheat States of North Dakota, South Dakota, Minnesota, and Montana during the four crop years 1923–1926 had a farm value of over $26,000,000. Practically all of the weed seeds found in the threshed grain can be readily removed from the grain and the screenings thus removed make valuable farm feed. Assistance was given manufacturers in the development of a new indented belt type of cleaner for attachment to the deck of the threshing machines, an improved type of self-cleaning sieve for threshing machines, and in experiments with other types of cleaners adapted for cleaning grain at the threshing machine and at the farm granary which were developed in cooperation with this bureau. The Bates aspirator developed in this bureau for cleaning grain at the threshing machine was tried out on a rice thresher in California. This experiment was entirely satisfactory, with a result that it has created a considerable demand for this type of cleaner for rice threshing.

Publicity was given to the fact that savings can be made by the producers by cleaning their grain and rice for both seed and market purposes. This information was presented in the form of illustrated lectures, posters, newspaper articles, exhibits, charts, and mimeographed material, and also by means of a special grain train which was run through Minnesota and North Dakota.

BULK HANDLING OF GRAIN

Bulk grain-handling investigations were continued in the Pacific Northwest. Statistics obtained from these investigations show that a material saving can be made on the farms and at the terminal points in handling grain in bulk rather than in sacks. Wheat exported from Pacific coast ports is now very largely handled in bulk, but the producers in that section still handle most of the grain in sacks. A new office was established at San Francisco, Calif., during the year to assist the grain producers in that State in changing over from the sack to the bulk method of handling grain.

WASHING SMUTTY WHEAT FOUND EFFECTIVE

During the past two crop years there has been a large increase in the percentage of wheat which graded "smutty" when it arrived at the terminal markets from country shipping points. Smutty wheat takes a material discount in price when it is sold on the market. The investigations have shown that by washing the smutty wheat in commercial wheat-washing machines a considerable saving can be made in the value of the wheat for milling purposes and that the cost of washing is more than offset by the increased price which the washed wheat brings on the market.

A new simple system was developed for measuring accurately the degree of smut present in smutty wheat for use in the grading of smutty wheat under the provisions of the United States grain standards act. The method consists of washing the smut off from a given quantity of wheat and collecting the spores on a filter paper, which filter disk can then be compared to standard filter disks. This method makes it possible for all inspectors to arrive at uniform results relative to the smut factor in their inspection and grading work.

A new type of sieving machine for inspecting and grading grain and rice was developed. In this machine one or more sieves are held in a movable frame which is operated by a motor. The results from the use of this machine are more accurate and uniform than can be obtained by hand sieves. This device has been adopted by commercial rice-inspection departments for use in grading rice.

A modification of the sample dividing device (Boerner sampler) used in connection with the grading of grain was developed and has come into commercial use in connection with the sampling of grain being loaded into vessels and barges.

DIVISION OF DAIRY AND POULTRY PRODUCTS

ROY C. POTTS, *in charge*

DAIRY-MARKETING INVESTIGATIONS

In cooperation with the Oregon Agricultural Experiment Station, a survey was made of the dairy marketing conditions, especially for fluid milk in the Portland market, with respect to

economic changes in production, distribution, and growth of the market milk business. It is contemplated that the report will be published in the near future by the Oregon Agricultural Experiment Station.

In cooperation with the New England Research Council, data were collected, and a brief report prepared on the tank-car and tank-truck shipments of milk and long-distance railroad shipment of cream.

A preliminary study of the milk marketing situation in the St. Louis market milk district was made at the request of the St. Louis Milk Producers' Association and the National Milk Producers Federation. Following the study assistance was given the former organization in revising its by-laws, drafting a new contract with its members, and in determining on a new plan of business operation.

POULTRY AND EGG-MARKETING INVESTIGATIONS

An economic survey of the live poultry industry in New York City was made and a preliminary mimographed report published. This survey was undertaken in cooperation with the New York Food Marketing Research Council and other local agencies. It covered records for a two-year period of the volume, costs, and methods of marketing live poultry, also methods of establishing prices on live poultry. An outgrowth of this study was the organization of a live poultry exchange for which tentative by-laws, trading rules, and live poultry grades were prepared for the Exchange.

A brief survey of the quality of Pacific coast eggs and the demand for them in various channels of trade in eastern markets was made in New York City, Albany, Buffalo, Cleveland, Detroit, and Chicago. The general consensus of the trade was that not a great difference existed.

POULTRY AND EGG INSPECTION SERVICE EXPANDED

Notable developments and further expansion of the poultry and egg inspection service occurred during the year. In California and Missouri where the egg-inspection service was carried on in cooperation with the State departments of agriculture, the service was extended to a number of additional shipping points in each State. Four firms at San Francisco and one at New York were authorized to use certificates of quality for U. S. No. 1 extras (retail grade) on their carton eggs.

The number of egg inspections made at Philadelphia and New York showed an increase, especially at the latter city, where during the spring months of 1927, over 500 inspections were made monthly. At Philadelphia one of the cold-storage warehouses utilized the inspection service to ascertain the quality of eggs offered for storage and on which loans were desired by use of the warehouse certificates as collateral.

An important development was the establishment of an inspection service on live poultry at New York City in cooperation with the New York Live Poultry Commission Merchants' Association, and the Greater New York Live Poultry Chamber of Commerce. This service was started in November, 1926, and required a personnel consisting of a supervising inspector and 12 licensed inspectors, 6 of whom were qualified veterinarians. This inspection service involves examination of nearly 12,000 carloads of poultry annually for crop and health conditions, which is required by the New York City Board of Health. It is made in accordance with rules and regulations promulgated by the Secretary of Agriculture and instructions issued by the chief of the Bureau of Agricultural Economics. It is planned to extend inspection work on poultry to include dressed poultry, tentative grades for which are being formulated; also to extend the service to eviscerated poultry intended for use in the preparation of canned poultry food products for export.

BUTTER INSPECTION SERVICE HELPS IMPROVE QUALITY

The butter inspection service in Minnesota was continued in cooperation with the Minnesota State Department of Agriculture and during the year more than 80,000,000 pounds of butter were inspected. A further marked improvement in the quality of butter manufactured by more than 400 creameries was noted, the percentage of 93 score butter increasing from 33 per cent in February, 1925, to over 70 per cent in February, 1927. A standard of requirements for butter making, prepared by the supervising inspector in cooperation with the field men of the the association of creameries, was accepted as the guide for the quality improvement work.

MONTHLY ESTIMATE OF BUTTER PRODUCTION

With additional funds provided in the appropriation act, monthly esti-

mates on butter, cheese, and condensed milk production were inaugurated in July, 1926. These estimates are now issued about the 20th of each month, while previously the production was not known until the quarterly report was issued. It is of interest to note that for the six months, July to December, 1926, inclusive, the actual production of creamery butter was 691,982,000 pounds, and the estimated monthly production totaled 674,896,000 pounds or 2.53 per cent less for the period, and that the monthly estimates varied only 0.55 to 3.73 per cent from the actual monthly production. These monthly estimates of production of butter and cheese and the monthly reports on condensed, evaporated, and dry milk furnish very timely information regarding the production of the principal manufactured dairy products.

FIFTEEN STATES COOPERATING IN COMPILING QUARTERLY PRODUCTION REPORT

Progress was made in the compiling of reports on the quarterly production of manufactured dairy products. Cooperation has been encouraged and at the present time agreements are in effect with 15 States. Under these agreements an agency within the State is charged with the responsibility for collecting dairy statistics. The advantages of the arrangement are the elimination of duplication on the part of reporting firms, more effective follow-up work in the States, which is necessary on account of delinquent firms, more complete statistics for each State, and the publication of more timely statistics. The extension of these cooperative agreements, together with the installation of more thorough methods, should be productive of the most complete and accurate statistics on the production of dairy products which can be produced.

MARKET NEWS REPORTS EXTENDED

The principal extension of the market news service occurred at the New York City office, where the service was extended to include live poultry and fluid milk and cream. Daily, weekly, and monthly live poultry market reports are now issued, which, however, do not as yet contain price information. It was the intention at first to include the reporting of prices, but after a very thorough canvass of the situation it was decided that this phase of the work should not be undertaken at the present time. Market reports on live poultry, therefore, carry only statistical information, together with comments on trading and market conditions.

The market statistics on live poultry at New York City are a new contribution and considerable interest has been displayed in them by the poultry trade. Since these reports were inaugurated there have been many requests for them and at the present time the mailing list for this report is twice the size of any other mailing list maintained at the New York office. Much of the current information regarding live poultry is obtained through the cooperation of the live-poultry inspection office. Daily market reports show the cars available for unloading each day, the intended unloads, actual unloads, the origin of cars unloaded the previous day, and the make-up of cars in terms of percentages of the different classes of poultry. On account of the extreme interest on the part of the poultry trade for this information, blackboards were placed at each of the four live-poultry terminals. Through arrangements with the poultry inspectors at these terminals, current reports are posted each morning which provide the dealers and sellers at each terminal with a more complete picture of the supply situation.

Market reports on fluid milk and cream are also statistical in nature. These reports show the daily receipts of milk, cream, and condensed milk at all terminal receiving stations in the New York City metropolitan area, including information as to the States in which the shipments originated. Supplementing the daily reports are weekly and monthly summaries which with comparative statistics provide valuable information as to the amounts and sources of milk and cream arriving at New York City. Plans for the fluid-milk and cream news service include price reporting which will be undertaken eventually. This phase of the work has not been pushed beyond the carrying of price information in the weekly market comments.

Another addition to the market news service is the quarterly report of stocks of condensed and evaporated milk in the hands of wholesale grocers. This work was suggested by the trade association comprising many of the evaporated-milk manufacturers, and as worked out includes 38 of the more important cities from which condensed and evaporated milk is distributed. Schedules are sent quarterly to wholesale grocers and jobbers in each of these cities, requesting information as to stocks on hand four times

a year. The first report was for March 31, 1927, and the response from the wholesale grocers was satisfactory. This report should be a valuable addition to the statistics on condensed and evaporated milk, particularly after it has been in operation a year so that comparisons will be possible.

There is evidence indicating an increasing interest in the statistics contained in the various dairy and poultry market reports issued. This is shown not only by the large number of requests received and the large mailing lists which it is necessary to maintain, but by the uses to which market reports are put by various branches of the industry. It is known that our condensed and evaporated-milk market reports are used by some manufacturers in developing their sales policies and keeping their jobbers informed. The Philadelphia butter-market reports are used by a large number of southern creameries as a basis for the purchase of butterfat and the sale of butter. At Boston the chamber of commerce has discontinued all of its statistical and price-reporting work on dairy and poultry products and uses the information which is contained in the bureau reports. The Boston reports have been adopted as the price basis by Vermont creameries and as a part of the price basis of the New England Milk Producers' Association. The prices reported at San Francisco are accepted and used as the official price quotations, not only by the local mercantile exchange but by the trade in general at San Francisco and throughout California. The daily and weekly statistics issued at all offices regarding cold-storage holdings have become essential to the dairy and poultry trade, and through them much uncertainty in regard to the statistical position of the market has been eliminated. There is every reason to believe that these reports now have the confidence of the dairy and poultry trade.

HANDBOOK OF DAIRY STATISTICS REVISED

A complete revision of the handbook of Dairy Statistics issued by the Bureau of Animal Industry in 1922 has been made by bringing the tables up to date and by including many new tables of statistics. This revision of the handbook will shortly be published.

COLD-STORAGE REPORTS

WM. BROXTON, *in charge*

The work of the cold-storage report section consists of compiling and releasing the monthly cold-storage reports covering such commodities as fruits, dairy and poultry products, meats and meat products; the monthly cold-storage report on fish; and the monthly report of slaughterhouse operations.

The general cold-storage report, in addition to being released for totals of the United States, is published in Crops and Markets by geographic sections. Increasing requests are being made for more detailed figures, and many special tabulations have been published in response to inquiries from the trade.

Reports on slaughterhouse operations are received from 600 meat-packing establishments. From these reports material is obtained which is used in compiling statistics on the production of meats and animal by-products and as the basis for research studies.

DIVISION OF HAY, FEED, AND SEED

W. A. WHEELER, *in charge*

REVISION OF THE OFFICIAL HAY STANDARDS

Two years' experience in the use of the hay standards indicated the necessity of some changes and the possibility of others which would simplify the application of the standards. Revised standards were prepared, therefore, which were established by the Secretary as the official standards of the United States for hay, effective July 1, 1927. This work required the assembling and study of many samples of hay and numerous field trips to discuss the problems with producers and dealers.

The class "grass hay" was made a separate group and so revised that it will be applied to the grading of the mountain hay of Colorado and Wyoming, Bermuda grass of the South, and all other hays consisting of more than 60 per cent of grasses other than those for which specific standards are provided. The number of special grades has been slightly reduced and those now in effect can be more easily understood. The revision also incorporated in these special grades many of the factors which in the past were shown by additional notations on certificates. Under the old standards, color of timothy was measured by estimating the amount of green area present on the leaf, head, and stems. This has not been entirely satisfactory and during the year studies were made which provided for using the Munsell

system for measuring timothy color as well as for color of other kinds of hay. While this shows no change in the amount of green color permitted in the various grades in the standards, in actual practice it does slightly lower the minimum for color of No. 1 timothy hay. The Munsell method of measuring the color of clover hay and grass hay has also been adopted.

Slight changes were made in the color limits on some grades of the other classes. During the past year there has been a demand for some revision of the grades for grain hay prescribed by the Federal Specifications Board for Government purchases and the addition of a No. 2 grade for each class. After a number of conferences with representatives of the Veterinary Corps and the Quartermaster Department of the Army, the California Department of Agriculture, and others, a new set of specifications was prepared, submitted to the specifications board, and adopted by them.

There is a continuous demand for type samples of the various grades of hay for use in schools, by licensed inspectors, by various agriculture colleges, and by the trade. A large number of types have been distributed during the past year.

COLOR INVESTIGATIONS

Work has been done during the past year in adapting the Munsell color system to the measurement of green color in timothy, clover, and grass hay. Plans have already been made for a number of improvements in the color machine and a new machine is now being built on the basis of these plans. A color technologist has been employed, in cooperation with other divisions of the bureau, who has had a great deal of experience in color work. Some studies are being made in cooperation with the Bureau of Plant Industry, of the effect of cutting clover at various stages of maturity on its color.

MEASUREMENT OF HAY IN STACKS AND MOWS

In cooperation with the Division of Farm Management and Costs, agreements have been entered into with a number of the agricultural experiment stations to conduct an extended study of the measurements of hay in stacks and mows as compared to the weight of the hay. There has been a large demand for this type of information and it is hoped that formulas for measuring stacks and mows of all kinds for the various classes of hay will result from this study.

HAY-FEEDING EXPERIMENTS

During the year an agreement was completed between the War Department, the Bureau of Animal Industry, and this division, whereby extensive feeding experiments to determine the relative value of various kinds and grades of hay will be conducted. Army animals at large posts will be used for this purpose and the feeds will be paid for from regular Army appropriations.

ALFALFA-MEAL INVESTIGATIONS

A beginning has been made on a study of the problems involved in the standardization of alfalfa meal. A number of samples have been collected from various parts of the country and moisture tests made on these samples. Much more work will be necessary, however, before any definite conclusions can be announced.

STANDARDS FOR BEANS RECOMMENDED

United States standards for beans were issued as recommended standards September 1, 1926. Soon after these standards were issued they were adopted as the official State standards in Idaho, Montana, and Wyoming. They are being applied in these States under a joint Federal-State inspection service.

The Navy Department, having experienced considerable difficulty during the past two years in obtaining beans that met the desired specifications as to quality, appealed to this office for assistance. As a result Navy contracts were placed for these types on the basis of the United States standards, and U. S. No. 1 grade was made the detailed specifications as to quality.

FACTORS AFFECTING QUALITY OF BEANS IN STORAGE

Studies were begun of the factors which affect the quality of beans in storage. As a basis for these studies the Navy Department has made available for sampling by employees of this office all lots of beans stored at supply depots located at Mare Island, Calif., Hampton Roads, Va., Brooklyn, N. Y., and Boston, Mass. Samples also will be drawn from commercial lots of beans at original shipping points and

terminal markets. These studies involve close check and observation of such factors as moisture, damage, acidity, warehouse conditions, temperature, and humidity.

SOY-BEAN STANDARDS REVISED

United States standards for soy beans were issued in revised form, effective September 1, 1926. The revisons made were based on the results of the application of the standards issued in 1925 and on further studies of the soy-bean industry. The most important change was the addition of a "super" grade designated U. S. Extra No. 1 to take care of high-grade stock for which there is a demand from the seed trade.

HAY INSPECTION

The hay-inspection service has continued to increase during the past year. At the end of the year there were 91 designated and licensed inspectors as compared with 72 the preceding year. The service has been extended to the States of Wyoming and New Mexico during the past year and considerably increased in Texas and Nebraska, new inspectors having been licensed at Fort Worth, Clint, and Houston, Tex., and at several shipping points in Nebraska. During the past year six schools were held at various points for the training of additional inspectors.

As a result of the further extension of the service, two new supervision divisions were established, one in the Mountain States with headquarters at Salt Lake City and another on the Pacific coast with headquarters at San Francisco. New supervisors were employed to take charge of these divisions.

The number of inspections during the past year has shown a gratifying increase. The total number of inspections made during the year was 17,161, an increase of about 15 per cent over the preceding year.

The cordial relations with the various Government departments purchasing hay have continued through the present year as in the past, considerable work being done with the Army to develop a more suitable ration for Army horses and to provide for the advantageous handling of controversies about the quality of hay delivered on Army contracts. The present arrangements are that wherever possible final decision in these controversies rests with this bureau. The quartermaster general states that the Army has made a saving of approximately $415,000 on its purchases of forage during the past year as compared to the preceding year. This is partly due to prices being somewhat lower during the past year but mostly due to savings on account of better buying and inspection methods inaugurated in cooperation with this bureau. The Bureau of Efficiency recently has recommended that the District of Columbia have all hay purchased by them inspected by this bureau upon delivery.

BROOMCORN INSPECTION

As a result of the small beginning in this work made in Oklahoma in 1926, an inspection service of considerable size has been developed in that State during the present year. Two schools for training inspectors were held at Oklahoma City in cooperation with the Oklahoma State Market Commission. At the present time there are eight inspectors licensed in cooperation with the State of Oklahoma. Inspection service for broomcorn was also established last winter for a short period at Wichita, Kans.

The total number of inspections during the year was 10,931 bales as compared with 826 bales during the preceding year. The Oklahoma department expects to extend the service which it is operating in cooperation with this bureau to the western part of Oklahoma during the coming year and it is probable that some work can be done also in New Mexico and Colorado.

BEAN INSPECTION

An inspection service for beans was started in the fall of 1926 in the intermountain States of Idaho, Colorado, Wyoming, and Montana. Since that time Federal bean inspectors have also been stationed at San Francisco, San Antonio, Salt Lake City, and Atlanta. The inspectors in the intermountain States provide Federal inspection for practically all of the bean-producing territory of that section.

SOY-BEAN INSPECTION

The soy-bean inspection service was established two years ago with inspectors at several shipping points in North Carolina and at Richmond, Va., and Chattanooga, Tenn. During the past year the service was extended to two of the large receiving markets in Illinois and to Norfolk, Va. and Atlanta, Ga., and considerable increase in the demand for inspection from re-

ceivers has been noted. The entire volume of inspections shows an increase of approximately 50 per cent over that for the preceding year.

SEED STOCK RECORDS AID IN VERIFYING ORIGIN

The United States Department of Agriculture and State experiment stations are doing intensive work to determine the adaptability of various kinds of seeds from different sources. They have already learned, for example, that Italian red clover does not do well in the United States, that alfalfa seed from Arizona is not adapted for sowing so far north as Kansas, and that Tennessee anthracnose-resistant red clover is the best strain for the southern part of the clover belt, where resistance to disease is the main consideration. Because origin of certain kinds of seed is apparently of importance and influences the price at which they sell, false information with regard to origin is often given. Staining as provided for under the Federal seed act protects the alert buyer against the substitution or misrepresentation of imported red clover or alfalfa for domestic seed, but during the past five years only about 15 per cent of the alfalfa and 20 per cent of the red-clover seed sown in this country were imported. This division has reached the conclusion, after intensive study in the field, that a system of complete records which preserves the identity of the seed, from the time it is received from the grower until it leaves the seedsman's warehouse, together with outside supervision, would go a long way toward insuring that the correct information as to origin would be passed on to the buyer.

Seed-stock-record studies, started last year, have been continued. About 60 seedsmen have been visited and approximately 250 record forms obtained from them. These forms have been studied, and the best features incorporated in model forms such as receiving, bulking, stock, shipping, and invoice records. A limited number of these forms have been supplied to the seed trade for suggestions.

The work on seed-stock records which was presented at the second seed-marketing conference held in Chicago, received the indorsement of that conference, and later also that of the International Crop Improvement Association and the Wholesale Grass Seed Dealers' Association (now known as the Farm Seed Association of North America). These organizations recommended that the work be continued, and that a complete system of inspection and verification of stock records of seed handlers wishing to sell verified-origin seed be devised. Such a system has been devised, and tentative provisions covering the verification of origin and identity of seeds were drafted, and submitted to interested seedsmen in attendance at the seed-trade convention in June, 1927, in Detroit. A sufficient number of seedsmen have already indicated a desire to participate in the proposed seed verification service to warrant going ahead with the plans and making the service effective as early as possible.

SEED-REPORTING SERVICE

The seed-reporting service was of assistance to the Red Cross flood relief office in Memphis in locating supplies and in keeping in touch with prices of cottonseed, seed corn, and forage-crop seeds, so that "up-to-the-minute" market information could be given to county Red Cross chapters.

The special reports on vetch and ryegrass seed were continued, and elicited favorable comments from far-Western growers and Southeastern consumers. During the year 109 mimeographed seed reports were distributed. As in the past, the same four main kinds of reports were issued, namely, outlook, price and movement, shipment, and weekly seed reviews. In addition, retail prices in March, April, and May, a prospective-demand report on March 11, and a retail-seed-sales summary on July 16 were issued.

GRAIN, HAY, AND FEED MARKET NEWS

The effectiveness of the grain, hay, and feed market news service was materially increased and the service was extended to several new areas. The development of better statistical data in the Washington office, together with increased efficiency in the field offices, has resulted in a material improvement in the character of the various market reports and reviews prepared by the division. The service was also strengthened by the more critical analysis of market data and by the addition of several important market contacts, particularly for the procuring of much-needed foreign-market information.

Effort was directed toward a more effective distribution of the service in the principal agricultural areas, and this was accomplished with practically no additional cost to the bureau. Approximately 600 regular market re-

views with definite dates of issue were prepared during the year and more than 250 daily or weekly market reports giving brief market summaries and current quotations on the principal commodities were issued on regular schedules.

Newspapers and radio stations continued to be the principal publicity agencies. More than 300 newspapers, with over 5,000,000 circulation, mostly in the farming areas, published the various reviews regularly. Large farm journals carried semimonthly or monthly reviews to their several hundred thousand subscribers. The principal radio stations throughout the country broadcast the weekly reviews and many of the daily reports.

Approximately 4,500 banks located in the central and northwestern grain-producing States are assisting the bureau in disseminating the information carried in the weekly grain, hay, and feed-market reviews, by posting the reviews on their bulletin boards and incorporating pertinent parts of the reports in their communications to their farmer patrons.

Nearly 600 cooperative elevator managers have requested the weekly grain-market reviews, and in most instances have expressed their intention of posting the report for the benefit of their customers.

WORK OF BRANCH OFFICES BROADENED

The market news work in the branch offices at Minneapolis, Chicago, and Kansas City, was broadened to more effectively serve the agricultural interests of the surrounding States. From Minneapolis a special grain-market news service featuring quotations on wheat on the basis of protein as reflected in the price paid for the different types of grain in that market was furnished to the Northwestern States. The special feed-market news service developed in the Minneapolis office in cooperation with the State Department of Markets in Wisconsin was extended to Minnesota. Additional special reports have been inaugurated at Chicago and Kansas City.

ADMINISTRATION OF THE UNITED STATES WAREHOUSE ACT

H. S. YOHE, *in charge*

TEN YEARS UNDER THE WAREHOUSE ACT

August 11, 1926, witnessed the tenth anniversary of the passage of the warehouse act. Progress during the first four and one-half years was slow, as was evidenced by the fact that on April 1, 1921, there were licensed only 238 cotton warehouses with capacity to store but 429,975 bales of cotton, 56 grain warehouses capable of accommodating 2,108,400 bushels of grain, and 5 wool warehouses with capacity for 24,375,000 pounds of wool.

Marked progress has been made since 1921, not only in the tremendous increase in the warehouses licensed for the storage of the commodities originally covered by the law but in the addition of new commodities to the list of products eligible for storage.

The warehouse capacities licensed under the act on June 15, 1927, were as follows:

Cotton---bales	2,711,050
Grain---bushels	36,738,364
Wool---pounds	27,966,250
Tobacco---do	558,216,000
Peanuts---tons	10,478
Broomcorn---bales	1,000
Beans---hundredweight	205,547
Potatoes---do	243,328
Sirup---gallons	200,000
Dried fruit---hundredweight	7,972,720
Canned foods---cases	1,097,000
Cottonseed---tons	7,500

ADDITIONAL PRODUCTS ELIGIBLE FOR STORAGE

On June 11, 1926, canned foods (fruits and vegetables) were made eligible for storage under the warehouse act. This action was taken in response to demand from various parts of the country. Large warehouses in Maryland, Indiana, Illinois, Virginia, Iowa, Missouri, Arkansas, and Oregon have been licensed and additional applications are pending. A very substantial increase is expected in this field during the coming year.

On August 24, 1926, regulations for the storage of prime cottonseed were promulgated. This action was taken at the instance of growers of cottonseed, cottonseed-oil interests, and bankers. That the department's regulations for the storage of this product make for sound collateral is evident from the ruling made by the Federal Reserve Board shortly after the promulgation of the regulations that bankers' acceptances, secured by cottonseed properly stored in a Federally licensed warehouse, are eligible for rediscount at Federal reserve banks.

SPECIAL INVESTIGATIONS

While the work in connection with the administration of the warehouse act consists primarily in the licensing of warehousemen, inspectors, graders, and weighers, and in enforcing the law

and the various regulations thereunder, it becomes necessary for a proper administration and extension of the law to new commodities to make various investigations. No product can safely be added to the eligible list until studies have been made to determine best practices followed in the storing of the particular product and until regulations are drafted to control the storage of the product. During the year, in answer to repeated demands, special studies were made with a view to ascertaining whether frozen berries and farm seeds might be added to the eligible list.

Special investigations have also been made in the field of grain warehousing, largely with a view to improving and perfecting present methods. These studies related particularly to improving methods for sampling bulk grain in elevators and to developing adequate records for houses operating under the law.

STANDARDIZATION WORK

TOBACCO STANDARDS

Under the warehouse act authority is granted to develop standards and grades for various products. For several years tobacco standardization work has been in progress. One outstanding accomplishment in this field during the past year was the completion of United States standard sizes for determining length of tobacco. Under these standards provision is made for six different series of sizes with variations suitable for measuring and stating the length of all types of American-grown tobacco. The results of this work appear in Department Miscellaneous Circular No. 83, entitled "United States Standard Tobacco Sizes."

During the year standard grades for Burley tobacco were also prepared and issued. Of all types of American-grown tobacco, Burley is produced in the largest amount. Important revisions were also made in the grades previously issued for eight other types. Investigations are now in process to develop standard grades for Maryland tobacco.

CANNED-FOODS STANDARDS

Following the placing of canned foods on the eligible list for storage under the law, it soon became apparent that there was a real need for standardization work in this field if warehouse receipts were to be of real service. What one canner of tomatoes may pack as a fancy grade another would regard as an extra standard grade, while a packer of first-class products would regard the same product as of standard grade only. Such variation in grading causes confusion and does not permit the banker to accept receipts on the basis of grades stated thereon. Besides, it forces the housewife to buy brands rather than goods on the basis of quality. With a view to improving this condition, studies have been made to develop proper grades for various canned fruits and vegetables. At this time tentative standards have been drafted for canned tomatoes, peas, corn, and stringless beans, and others are in process. In this work the department is working closely with the trade and canners' associations, and it is receiving whole-hearted support.

AMENDMENTS TO REGULATIONS

During the year a number of amendments were made to the various regulations. An amendment made to the regulations for warehousemen storing sirup permits the storage of sirup in bulk in large tanks provided such sirup is held at a certain temperature.

The grain-warehouse regulations were amended by substantially increasing the fees collected by the Government for original inspection of warehouses. Prior to this amendment the fee was at the rate of $1 for each 10,000 bushels storage capacity. It is now $2. The minimum fee before amendment was $5. It is now $10. The maximum fee was $50 regardless of the capacity. It is now $100.

SOME BENEFITS FROM THE LAW

In the flooded areas in Mississippi there were several licensed cotton warehouses which suffered heavily. Some of these houses had large stocks of cotton. With a view to protecting the various interests and to salvaging as much cotton as possible a Federal receiver was appointed for several houses. Both the receiver and the salvage company requested the department to furnish its records and to assist in making adjustments. The department's records were accepted by all parties as accurate and dependable, and they were of great assistance in effecting proper settlements.

From different sections of the country reports reach the department as to the increasing value and acceptability of Federal warehouse receipts for loan purposes. The standing these receipts have attained is resulting not only in

cheaper money but in money in certain centers being made available which was heretofore denied to agriculture. In certain grain-producing States grain loans supported by Federal warehouse receipts have been made at rates as low as 4½ per cent, and the bankers were actually seeking this type of paper. In one grain banking center money was reported offered at 3¾ per cent.

In the dried-fruit areas of the Northwest a cooperative growers' organization which placed its fruit in licensed warehouses in the past year was able to avail itself of money as low as 5 per cent through the intermediate credit bank, and the local banks also when offered the Federal warehouse receipt voluntarily reduced their rates to this organization from 8 to 6 per cent. Another cooperative growers' organization packing fruit and vegetables found 5 per cent money instead of 7 per cent when it offered the Federal warehouse receipt as collateral.

With the Federal warehouse receipt as security it should be an easy matter for anyone entitled to a loan for marketing purposes to secure ample credit at reasonable rates. Too frequently, however, organizations attempt to secure loans on the basis of warehouse receipts which under certain conditions would fail as collateral. In too many instances the warehouse set-up is not of such a nature as to afford independent custodianship of the product represented by the receipt. In such cases, even though the local banker, knowing the person who wants the loan to be reliable, may make the loan, he finds that he can not pass the paper supported by such warehouse receipts along for rediscount. The rediscounting banks—Federal reserve and other banks—are insisting on disinterested custodianship of the product represented by the warehouse receipt.

STATISTICAL AND HISTORICAL RESEARCH

O. C. Stine, *in charge*

The primary aim of this division is to collect useful statistical and other historical data, and to analyze agricultural economic problems so as to provide a better basis for working out national agricultural policies, and to provide farmers with economic information useful in deciding what to produce and when to market their products. The outstanding developments of the past year have been made in the field of foreign competition and demand and in price analysis. Regular monthly economic reports dealing with cotton, wheat, and tobacco, and general economic conditions as they affect the purchase of agricultural products in continental Europe have been established. Crop and market reports by United States consuls have been expanded. A beginning has been made in the study of measures by foreign countries to control production or stabilize the marketing of agricultural products. In price analysis progress has been made in the development of a better understanding of the relations between agriculture and industry.

FOREIGN COMPETITION AND DEMAND

In the past year regular monthly economic reports dealing with the consumption of and conditions of the market for cotton, wheat, and tobacco in practically all of continental Europe have been put upon a substantial basis. These reports, prepared by the Berlin office, are being supplemented by additional information from other sources concerning the production, consumption, and market conditions in other countries and issued as special monthly reviews. Reports dealing with fruit and with general economic conditions are also being continued and expanded. Information from China, collected by the representative of the bureau sent to the Orient, has also made a valuable contribution to the current surveys of foreign crop and market conditions. In the past year the United States has had unusually large quantities of apples and cotton to market. By means of reports from the European representatives the bureau has been able to keep in close touch with market conditions and to keep the interested parties informed as to the movement of these products into consumption. The United States has also had large quantities of wheat and tobacco to market and through its representatives in Europe and China the bureau has been able to keep in close touch with the markets for these commodities and to keep producers and exporters better informed than ever before of consumption and of market requirements.

Believing that a knowledge of measures undertaken by foreign governments and cooperative agencies to control the production or the marketing of agricultural products would be useful in developing policies for the United States, an attempt has been made to collect all available informa-

tion concerning such measures. Preliminary analyses have been made of the control of the production and marketing of sisal in Yucatan, of rubber in the East Indies, currants in Greece, and cotton in Egypt. The delegate of the United States to the International Institute of Agriculture, upon the request of this bureau, visited Egypt and made a special study of government regulations with reference to cotton production and marketing. This study has been mimeographed under the title "Government Measures to Aid Egyptian Cotton Growers." He is also making a study of the Greek currant control. Information on this subject has also been contributed by another representative of the bureau traveling in New Zealand and Australia. There is an opportunity for a large amount of work in this field, and the results may be very useful in avoiding repetition of experimental errors and shaping an effective policy for this country.

The foreign crop and market reporting service has been further developed along practical lines. The official crop and livestock reports cabled by the International Institute are being supplemented by special reports from consuls and representatives of the Department of Agriculture in foreign countries. The agricultural commissioner in Berlin has cabled weekly reports of European weather conditions affecting the prospects for crops. These reports have been more comprehensive than information available from any other source. Among the most valuable reports received in the past year have been grain collections and crop conditions in Russia, which in the past year has been a factor of some importance in grain markets of Europe. The agricultural commissioner sent to China has also made timely and valuable reports with reference to the rice market in Japan, the condition of the market for American tobacco in China, and supplies of eggs and peanuts being produced in China for United States markets. The political disturbances in China have increased the importance of having a well-trained agricultural observer in the country to report conditions, both as to production for United States markets and prospects for marketing American products in China.

The United States consuls at certain posts are also performing a very practical service in reporting prices and shipments of products from foreign countries to the United States, where they compete with domestic products. In the past year the weekly reporting of the Bradford wool market by the United States consul at Bradford was inaugurated. The continuation of the reporting of shipments of onions from Spain and Egypt to the United States has proven to be a valuable service for the producers and shippers of onions from different parts of the United States to the large Atlantic coast markets. The cables from consuls state the quantity of onions, name of ship, and probable arrival, and have been found to be both timely and reliable. A similar service has been started with reference to shipments of corn from Argentina. Plans are being made for reports from the consuls on the west coast of Mexico on the production of early vegetables in that region and shipments to the United States. Cables are received from the consul in Sicily on the price of export lemons at Palermo and monthly exports to the United States.

The number of reports issued during the year was increased over the past year, the special foreign-service reports increased in number from 260 to 290, and the mailing lists for these reports increased from 3,000 to 6,000. The demand for these special commodity reports increases as the service becomes better known.

An issue of foreign Crops and Markets, containing current reports and results of research, has been prepared each week. The circulation has increased moderately and now amounts to nearly 2,500. This is not a large figure, but it should be remembered that this publication is primarily for research workers and others who may make further use of the material in republication. Many comments received indicate that it is meeting a real need by making available a large amount of basic statistical and other historical information along with up-to-date world crop and market developments.

In some cases it seems very important to have a fairly accurate indication of the outturn of crops in important countries in advance of the official estimates. Many countries are late in making official estimates of crops. Earlier estimates or forecasts of production in important countries would improve the accuracy of early estimates of world production and enable producers in the United States to make their marketing programs earlier in the season and with more certainty as to world market developments. Climatic data and condition reports are being analyzed to provide a basis for forecasting wheat crops in advance of

the Government estimates in India, Italy, France, Germany, Argentina, and Australia. The results obtained thus far have been quite satisfactory. In the past year, for example, the Government estimates of the Argentine wheat crop were anticipated by one month, the calculated forecasts being very close to the later official estimates. The outturn of crops in France and Germany also have been estimated fairly accurately several months in advance of the Government estimates.

Research in the field of foreign demand promises some valuable results. An analysis is being made of Cuban imports to determine the principal factors affecting Cuban purchases of agricultural products. It has been found that the value of Cuban exports of sugar has a very close relationship to purchases of agricultural products. Further analysis shows that variation in the value of Cuban exports affects some agricultural products much more than others. It seems greatly to affect the imports of fruits, for example, but not very much the imports of wheat flour. This study is being made not only to provide a basis for estimating or forecasting Cuban purchases, but also as an experiment in analysis of foreign demand for agricultural products. As this experiment is completed, similar studies will be made of other foreign countries.

Another line of research is the collection of information as to the effect of import duties, ocean freight rates, and quarantine restrictions upon the foreign markets of the United States.

AGRICULTURAL INCOME

Research continues to improve the estimates of income from the agricultural production of the United States. All the different items are reexamined each year and brought up to date. Plans have been made in cooperation with other divisions to estimate income by States on the same basis as the estimate for the United States.

Agricultural income declined this year (1926–27) after a continuous improvement from 1921 to 1925. Gross income declined $600,000,000. This reduction was due mainly to the decline in income from cotton but to some extent also to a decline in the income from grains and fruits and vegetables. The income from livestock increased slightly. Income available from capital, labor, and management per farm family declined from $922 for the year 1925–26 to $853 in the year 1926–27, which is about the same as for the year 1924–25. Between January, 1926, and January, 1927, the current value of farm property declined $1,500,000,000, and on January 1, 1927, amounted to approximately $58,000,000,000, as compared with $79,000,000,000 in the year 1919–20. The rates earned by farmers on net current value of farm property (current value less value of property rented from and debts owed to nonoperators) declined from 4.3 in 1925–26 to 2.7 per cent, the lowest rate since 1923. The wage earnings of the average farm family in relation to the level of 1919–20 continue to be less than those of a hired farm hand and considerably less than those of a factory employee.

It should be noted in this connection that there is considerable variation in the incomes of farmers. Another study of farm incomes in 1926 based on actual reports by 13,475 farmers indicates that after taking into account changes in inventory the receipts exceeded the expenses by $1,500 or more on about 25 per cent of these farms, while on 11½ per cent of the farms the receipts were not sufficient to cover expenses.

PRICE ANALYSIS

The commodity-price studies are being continued. The purpose in each case is to understand prices and measure the influences of different factors in causing price changes. A preliminary study of cotton prices has been completed and a bulletin entitled "Factors Making the Price of Cotton" has been submitted for publication. Studies of the price of corn, apples, wheat, wool, and dairy products are now under way. Representatives of this division with representatives of several other divisions have continued the preparation monthly of the price situation for publication in Crops and Markets and for distribution to State statisticians and economists who are preparing special reports of this kind for their respective States.

Some advance has been made in a study of the relation of agriculture to the business cycle. It is believed by some that one of the most important factors in the business cycle is the variation in agricultural production due to factors over which the farmers have little or no control. It is assumed by many that there is a very close relationship, some saying that there can not be business prosperity without a prosperous agriculture and others that business prosperity is essential to a prosperous agriculture. Continuation of business prosperity through the past few years with the continuation of an agricultural de-

pression has raised some doubt as to their being a close relationship. A careful analysis of farm prices in relation to business cycles over a long period of years has shown that in earlier periods as well as in recent postwar years business has been prosperous for periods of several years, while agricultural prices remained relatively low. The explanation seems to be that cheap food and raw materials contribute to the prosperity of urban workers in many industrial lines, especially those which have a large and expanding urban market; and that, on the other hand, weakened agricultural purchasing power hurts a few industries such as fertilizers and farm machinery, which depend largely or almost entirely upon the farm market. After a period of some length low prices may check expansion of agricultural production, while the demand for agricultural products continues to increase, and then unfavorable seasons cause short crops and high prices for the food and raw materials furnished by agriculture. Such periods in the past have usually been accompanied by or closely followed by a business depression. It seems, therefore, that both the accumulated results of an agricultural depression and seasonal production cycles are important factors in causing business depressions. It is also evident that a business depression reduces the demand for some agricultural products, particularly raw materials used in industries that are depressed, and it may, by reducing the purchasing power of consumers, reduce the demand for such products as butter and beef. But it is also evident that while business prosperity may increase the demand for certain agricultural products the elasticity in the demand for these products is not sufficient to guarantee agricultural prosperity.

TRANSPORTATION

Major emphasis in the transportation research has been given to the preparation of material requested by farmers' organizations and others engaged in presenting transportation problems before the Interstate Commerce Commission. In addition to the preparation of such material, however, index numbers of freight rates on wheat and livestock have been completed. These index numbers cover many representative points and are believed to be fairly accurate measures of the changes in the rates upon which the bulk of these commodities move. A comprehensive study of the transportation of cotton was also begun. Data as to cotton movements and rates have been collected. The purpose is to construct an index number of freight rates on cotton and to describe completely the handling of cotton in transportation.

HISTORICAL RESEARCH

Historical research continues to collect information for use in the analysis of causes of shifts and changes in agricultural production and income. A new development in the past year has been the collection, in cooperation with the States, of prices farmers received in Maryland and Virginia covering a long period of years. From the records of farmers, mills, stores, and from old newspapers, prices have been collected in Maryland back to 1851 and in Virginia back to 1880 with some records covering earlier years. These data are being compiled so as to provide a continual series of prices for the important commodities and index numbers of prices farmers receive for the products they have to sell. It is expected that the results will be useful in explaining shifts that have taken place in agriculture, in studying the effects of prices upon production, and in indicating probable future developments of production in these States. Several other States are interested in this project. Work also was continued on a cooperative project with the State of Montana in the study of the history of the early development of the cattle industry in that State. For next year a study of the lifetime experience of the farmer in relation to his environment, including the effect of local, national, and international developments upon his type of farming and income is planned.

DIVISION OF AGRICULTURAL FINANCE

NILS A. OLSEN, *in charge*

The work of this division covers problems in credit, taxation, and insurance, in so far as these pertain to agriculture.

RURAL CREDIT

The work in rural credit has included an inquiry into the sources, costs, and problems involved in production credit for cotton growers. This inquiry was made by means of a questionnaire addressed to lists of growers in the 10 more important cotton States.

Intensive local studies of all forms of credit used by farmers, and of various factors affecting the need, cost, and availability of credit, have been made in cooperation with State agricultural institutions in North Carolina, South Carolina, Georgia, and Oklahoma. A similar project has also been inaugurated in Arkansas. In these local studies the cost of credit to individual farmers has been related to the type of farming, size of farms, sources of credit, degree of self sufficiency of the farm with reference to food and feed supplies, and kind and length of tenure. Financial relations of landlords and tenants have been studied, as have also the relationships of credit to cooperative enterprises of farmers. Special consideration has been given to merchant credit and the possibilities of substituting for such advances more economical credit from banks and other specialized credit institutions.

A special study of livestock credit in Montana was made during the year in cooperation with the State agricultural college. This study, while applying specifically to the livestock districts of Montana, will give information of interest also to other livestock sections and particularly to such sections in neighboring States. In a large part of Montana, livestock is the basis for all production credit. Crop mortgages from grain-and-livestock producers are, as a rule, considered merely supplementary security.

In connection with local field studies in the States mentioned, the operations of agricultural credit corporations organized specifically to obtain discounts from the intermediate credit banks have been given special attention. A nation-wide study of such corporations is planned.

FARM TAXATION

Studies in farm taxation have in the main been conducted in cooperation with State agricultural colleges. Bulletins summarizing the results of such studies in Missouri and North Dakota have been issued by the cooperating agencies during the year. Each of these bulletins sets forth the relationship between the rent and taxes of a large number of farms in the States concerned. The tax systems of the States are analyzed and certain revisions are suggested to make these systems more equitable from the farmer's point of view.

Progress has been made on cooperative studies in Colorado, Massachusetts, Michigan, Oklahoma, and South Dakota. An intensive study of taxation in Michigan has resulted in the preparation of a bulletin which concerns the tax burden on agriculture and on other industries. This bulletin is one of a proposed series covering various aspects of the tax situation in the State. The work in Oklahoma has reached a point where results can be summarized, and summaries of the material secured in Colorado have been released to the press. Preliminary work has been done on a cooperative study in Virginia, where the Virginia Polytechnic Institute and the University of Virginia are cooperating and working with the bureau in a comprehensive survey of the State's tax system. Plans are under way for the initiation of several other State projects at the beginning of the new fiscal year.

Data have been gathered from farmers in all the States concerning changes in farm taxes since 1924. These figures will make possible an estimate based on census figures of the volume of farm taxes in the United States for the years 1924, 1925, and 1926, and will indicate those sections where material changes in farm taxes have taken place. A study of the relationship between taxes and cash rents in one or two counties in each of the more important agricultural States has been begun. The results of this study will be compared with material gathered for the year 1919, and will give a clear indication of changes that have taken place.

AGRICULTURAL INSURANCE

A special study of recent developments in farmers' mutual fire insurance was made. The 1,950 companies in this class now carry insurance on farm risks in the aggregate amount of about $10,000,000,000, which covers approximately one-half of all farm property in the United States insurable against fire. The average annual cost of this insurance is about 26 cents per $100 of risk. The opportunities of these local mutual companies to serve as conservation agencies as well as economical loss distributors by encouraging and promoting the elimination of fire dangers from the properties insured are very great. If the best methods and practices already in use by the more progressive of these mutuals were generally adopted, the cost of insurance would be greatly reduced and much property would be conserved.

During the year the division has contributed to the consideration of

farmers' insurance problems by State associations of farmers' mutuals, as well as by the National Association of Mutual Insurance Companies. Special assistance has been given to the work of a committee on farm fire protection working under the auspices of the National Fire Protection Association.

Data have been gathered also on hail, crop, livestock, and automobile insurance for farmers, with a view to making such informaton generally available. Assistance and advice has been furnished upon request to State farm bureaus, officers of farmers' mutuals, and others, on problems of agricultural insurance. One of the most striking recent developments in the field of insurance protection for farmers is that of mutual organizations to carry farmers' automobile insurance. This development has been limited largely to the Middle West. The insurance covers fire, theft, collision, property damage, and public liability, or, in other words, all the special hazards involved in the ownership and operation of automobiles. The cost of such protection in these new farmers' organizations has thus far been remarkably low.

DIVISION OF COOPERATIVE MARKETING

CHRIS L. CHRISTENSEN, *in charge*

Research, educational, and service work with farmers' cooperative associations became a specific Government activity, through the cooperative marketing act, approved July 2, 1926. The act provided for the establishment of the division of cooperative marketing in the Bureau of Agricultural Economics and for enlargement of the department's research, educational, and service work relating to cooperative marketing of agricultural products, cooperative purchasing of farm supplies, and other cooperative activities among farmers.

The work of the new division is based upon the needs of the expanding cooperative movement, and its practical application to the problems of the associations is kept in the foreground. Research projects and service work undertaken by the new division have been carefully designed to assist farmers and their cooperative associations with problems of organization, management, financing, merchandizing, and membership relations. Business technique and marketing methods evolved by farmers' cooperative enterprises are being analyzed and studied by marketing specialists. These analyses cover the operating methods and experience acquired by cooperative associations marketing dairy products, livestock, grain, wool, fruits, vegetables, cotton, and other agricultural commodities and the results of each study are made available to guide cooperatives along safe business lines. As the principles which make for success in cooperative business become better understood, we may look for a more efficient performance of marketing service by cooperatives.

SERVICE AND ADVISORY ACTIVITIES

In response to requests made personally, by mail, or by wire, by farmers and cooperative associations, the division is constantly furnishing information and advice with respect to the organization, management, and operation of cooperative associations.

Through its extensive contacts with cooperative associations and its study of their many problems, the division assembles a great many valuable data which are helpful in determining the policies of cooperative associations.

In addition to consultations with the directors and management of existing associations the staff has been called upon to assist and advise committees representing groups of agricultural producers who are contemplating organization. In many cases the division has been in a position to bring to the attention of the organization committee much valuable data bearing upon the economic problems surrounding the production and marketing of their product, and the form of organization structure and operating methods best adapted to the marketing of their particular commodity.

RESEARCH STUDIES

The research work of the division is directed along four major lines: (1) Study of the development of cooperative associations marketing particular commodities. These studies of the cooperative effort in each commodity group are historical, descriptive, statistical, and economic. (2) Business studies of individual cooperative associations which have been operating over a period of years. In these studies a detailed critical analysis is made of the organization, membership relations, pooling and accounting methods, financing, management policies, and merchandizing practices of individual associations, and of the external economic factors which affect their operations. The aim is to study, by the case method of research, the econom-

ics of cooperative organization and operation. Endeavor is made also to accumulate source data which will lead to the development of standards of business efficiency for cooperatives. (3) Research in legal phases of cooperative organization, financing of cooperatives, membership relations, and educational methods. (4) Studies of cooperative purchasing of farm supplies.

The results obtained from these studies may be published as bulletins, released in mimeographed form, given in great detail to the organizations immediately concerned through correspondence or personal conferences, or used in formulating general principles for the benefit of other organizations similarly situated, the type of publicity depending upon the individual case.

COOPERATIVE MARKETING OF FRUITS AND VEGETABLES

An economic study of the prune industry in Oregon and Washington was completed in April, 1927. This study was undertaken at the request of the prune growers, cooperative associations marketing prunes, other packers and distributors of prunes, and the agricultural experiment station and extension service department of the Oregon Agricultural College.

This study involved (1) determination of the factors influencing consumption of the product, (2) a study of the markets and distributing machinery, (3) consideration of the factors affecting production in this area and in competing areas here and abroad, and (4) determination of the present and probable future output of the product. The analysis which was made points the way to a sound program of production and marketing that should result in placing the industry upon a more satisfactory basis. Other divisions of this bureau and The New York Food Research Council assisted with the study.

COOPERATIVE MARKETING OF GRAIN

Two grain-marketing studies of major importance have been conducted, one concerning the wheat pools; the other, farmers' elevators.

It was felt that the activities of the Canadian wheat pools were of such importance and of such interest to farmers in this country that a careful analysis of their organization setup and methods of operation should be made and the results of the investigation made available to those interested. This study traces the development of cooperative activities in the marketing of Canadian grain since the opening of the grain-producing region of the Prairie Provinces. It shows the contribution of each period of development to succeeding developments, and particularly to the wheat-pool movement. The operations of the large cooperative elevator companies and of the present wheat pools are discussed in detail. A feature of the study will be a comparison of the development of cooperative grain marketing in Canada and in the United States.

The second study concerns farmers' elevators in the United States, and was conducted in cooperation with the State colleges and experiment stations of Montana and North Dakota. A group of farmers' elevators in Montana, North Dakota, and Minnesota were selected for study. Analyses of the expense of operation, hedging practices, effect of protein content, and other quality factors on returns, storage practices, and relation of side-line business to the handling of grain have been made.

The information obtained has been presented to a large number of officials of farmers' elevators through personal contacts, and through addresses and discussions at their State and national conventions. Such contacts have been made with representatives of approximately 100 organizations.

COOPERATIVE MARKETING OF DAIRY PRODUCTS

Research in cooperative marketing of dairy products has included the collection of data on a number of the important types of cooperative fluid-milk-marketing associations. The completed study will include a description and comparison of the organization set-up and operating methods of the various associations, their historical background, and economic analyses and discussions of individual associations and the environment in which they operate. Special attention is being given to the equity of pooling methods and price plans and the effect of the latter in controlling seasonal variation in production and the leveling out of periods of excessive and insufficient production.

At the request of 25 dairy cooperatives in the New England States a study was made which involved an economic survey and analyses of the facts surrounding the production and marketing of fluid milk throughout New England with special reference to

their cooperative marketing. The growth and development of the Boston milk shed, the source of New England's milk supply at the present time, its seasonal change in flow to market and the manner in which it flows were presented. The existing cooperative and other marketing machinery through which the marketing of milk is carried on at present was described. The study presents also analyses of fundamental economic facts dealing with the causes of changes in the supply and demand for milk and the factors influencing these changes. Possible economies that might be effected by the unification of existing facilities are pointed out, and the question of the optimum-sized unit is discussed. The question of competition with other areas, particularly the possibility of western supplies of cream in the New England market is given consideration.

COOPERATIVE MARKETING OF LIVESTOCK

The division has in its employ a specialist who has had practical livestock-marketing experience as well as training in economics, who is working closely with livestock cooperative associations for the purpose of enabling them to increase their efficiency. This work is making available valuable information on successful cooperative livestock-marketing practice. A study is being made of the organization, operating methods, and problems of cooperative livestock associations, including both the local shipping associations and the terminal cooperative commission agencies.

This division has cooperated with the livestock division of this bureau and with the Iowa State Agricultural College in a study of direct shipping and selling of hogs in Iowa. In this study schedules were prepared for reload stations, interior packers, and livestock producers. In the reload-station and packer schedules particular attention was given to operating practices of these buying agencies, including the methods of handling hogs and of determining prices paid to producers. In the shippers' schedule an effort was made to find out how many hogs the farmer fed and where and to whom he sold them, as well as the extent of competition among the various buying agencies for the farmer's hogs.

COOPERATIVE MARKETING OF WOOL

Representatives of 29 of the leading cooperative marketing associations, representing approximately 38,000 wool producers who market approximately 30,000,000 pounds of wool, met with officials of the department February 11–12, 1927, for the purpose of developing a program of research, service, and educational work relative to the cooperative marketing of wool. This conference was called by the Secretary under the provisions of the cooperative marketing act.

The first project undertaken in cooperative marketing of wool is a year's study of wool production and marketing in Australia and New Zealand. The wool specialist who was employed to conduct this study sailed for New Zealand and Australia in March, 1927. His investigations will involve a thorough survey and analysis of the practices and methods of wool marketing in Australia and New Zealand. The importance placed by the Australians on wool types for production purposes, the shearing of the fleece and the manner in which it is handled, and the system of centralizing wool and its shipment to the large markets are being studied. The functions and operations of the Australian Wool Council are also being studied. The purpose of these studies is to acquire information which can be applied to the cooperative marketing of wool in this country.

COOPERATIVE MARKETING OF COTTON

The division's work with the cotton associations has involved both research and service. Early in the year a report was made to the cotton associations on the attitude of the New England manufacturers regarding the cooperative marketing of cotton. Reports were made on the operations of the Staple Cotton Cooperative Association and on a membership study of two cotton associations.

In response to the increasing interest in cooperative gins among cotton growers and their cooperatives and the demand for information on organization and operating problems, the division has made a number of studies of cotton-gin operation in Texas and North Carolina. Studies have also been made of a group of 12 cooperative cotton gins in northwest Texas and of the development of cooperative cotton gins in Georgia as subsidiary or associated units of the Georgia Cooperative Cotton Growers' Association.

Close contact has been maintained with the cotton associations. Assistance has been given especially in connection with the problem of education

in the principles and practices of cooperative marketing. Approximately 30 special reports, including statistics, bulletins, and other material, were prepared and sent to the associations during the year as a part of this service program.

COOPERATIVE MARKETING OF TOBACCO

Studies were begun during the year on the cooperative marketing of tobacco. Information was gathered by a representative and preliminary reports were prepared on the cooperative marketing of tobacco in Maryland, in Wisconsin, and in the Miami Valley of Ohio, as well as a general report on the cooperative marketing of Burley tobacco. A membership study covering two tobacco-marketing associations was made also and the results of this study were published.

COOPERATIVE-BUSINESS ANALYSES

That phase of the research program dealing with detailed critical studies and analyses of individual cooperative associations is yielding most encouraging results and is commanding great interest among cooperative officials and directors. The results of these cooperative-business studies are also being widely used by colleges in their courses of instruction in cooperative business. These studies not only afford data for intensive research in cooperative business but give opportunity for the development of research methods which are proving of aid to cooperatives in studying their own problems.

A study of the joint-sales arrangement whereby the deciduous fruit of the California Fruit Exchange is sold through the sales organization of the California Fruit Growers Exchange was begun in June, 1926, and was completed during the year. This study was undertaken at the request of the board of directors of the California Fruit Growers Exchange, as it afforded an opportunity to make an intensive study of a joint-sales arrangement which has been in operation for over 25 years, and to reach conclusions which will be of value in service work with cooperative-association managements who are giving consideration to the possibilities of the joint use of sales organizations in the marketing of the associations' products.

On completion of the study a detailed report was made to the board of directors of the California Fruit Growers Exchange in which was stated the conclusion that during the period of operation of this joint-sales arrangement its operation had been beneficial to the interests of the members of both the California Fruit Growers Exchange and the California Fruit Exchange. The report was published by the California Fruit Growers Exchange for immediate distribution to the members of the boards of directors of the affiliated associations forming the exchange.

At the request of the board of directors of the Poultry Producers of Central California a business analysis of their organization was undertaken. The study embraces a brief analysis of the production side as found in California, and a very careful scrutiny of the operating methods and costs and other matters pertaining to the association's operations, together with a price analysis of the San Francisco egg market. It was found necessary also to include a very complete analysis of the New York egg market and of the interdependence of this and other large markets, inasmuch as New York seems to be the principal market in the determination of egg prices. A number of consumers, jobbers, and retailers in New York City were interviewed with the purpose of understanding the demand for Pacific coast eggs sold through the Pacific Egg Producers, a joint-sales agency operated by several Pacific coast cooperative egg-marketing associations.

At the request of the board of directors of the Producers' Livestock Commission Association, of National Stockyards, Ill., an analytical study is being made of the organization and operation of that association.

MEMBERSHIP RELATIONS AND FIELD SERVICE PROBLEMS

Among the most serious problems of cooperative marketing associations are the holding of adequate membership and securing the loyalty and intelligent support of their members. A study of the membership relations of cooperative associations marketing cotton and tobacco was made in cooperation with the Agricultural Experiment Station of the University of Kentucky.

Research work was begun in membership relations and field-service problems of cooperative associations handling fluid milk. This work has been conducted in the area of four of the larger associations by means of personal interviews with members and nonmembers in the territory served by these associations. This work has been conducted with the hearty coop-

eration of the associations and the agricultural colleges in the areas studied. It was designed to obtain information on which to build more effective field service and educational-extension programs. The agricultural colleges and the cooperative associations are now arranging educational material for use in correcting conditions revealed in these studies. This work has promoted a closer relationship between some of the agricultural colleges and the cooperative associations.

LEGAL PHASES OF COOPERATION

During the past year over 50 articles on legal decisions and related subjects have been prepared and published in Agricultural Cooperation. A mimeographed preliminary report, entitled "Cooperative Associations and Subsidiary Corporations," was issued. Assistance has been rendered cooperative associations and those interested in cooperation on their legal problems and the legal specialists of the division have participated in an advisory capacity in a number of important conferences. The revision of Department Bulletin No. 1106, entitled "Legal Phases of Cooperative Associations," is nearing completion.

FARMERS' COOPERATIVE OIL ASSOCIATIONS

The division, in cooperation with the University of Minnesota, completed a study of 41 farmers' cooperative oil associations that were active in 1925, 39 of which were located in Minnesota and 2 in adjacent territory. Data covering the organization, financing, management, and costs of operation of these companies were collected, largely through personal visits to the stations. The results of the study have been presented in a manuscript now ready for publication as a circular entitled "Organization and Management Problems of Cooperative Oil Associations in Minnesota."

EDUCATION AND EXTENSION IN COOPERATION

In the development of the cooperative movement there is an urgent need for the extension of the principles and practices of cooperation among farmers. The cooperative marketing act authorizes the division to promote the knowledge of cooperative principles and practices and to assist agricultural colleges, extension services, and cooperative associations in working out a comprehensive educational program in cooperative organization among farmers.

Efforts have been made to meet this need by promoting, in cooperation with the agricultural colleges, extension services, and the cooperative associations, short-time schools through which the principles and practices of cooperation are presented. These two or three day schools on cooperative marketing are usually held under the auspices of the agricultural college and extension service, with the various cooperative associations in the State and the division of cooperative marketing cooperating. The programs are especially designed for officials, directors, and field men of cooperative associations and others who are working to direct the cooperative movement in the State. The instructors are marketing specialists of the colleges, leaders of the associations, and representatives from this division.

Two new films, Cooperative Marketing—Pacific Coast Eggs, and Cooperative Marketing in the United States, have been added to a series of educational films designed for use by cooperative associations, extension workers, and others engaged in teaching cooperative principles and practices. A number of film-strip slides for the purpose of illustrating lectures on cooperation have been developed.

Arrangements have been made with the extension service whereby the division will make available the services of one of its cooperative marketing specialists for extension work in cooperative marketing. The aim is to assist in a closer coordination of the work of the extension services toward extending the principles and practices of cooperation among farmers.

HISTORY AND STATISTICS OF COOPERATION

The library on cooperation was enriched during the year by copies of several thousand financial statements and printed reports from cooperative associations. The files now contain data from approximately 11,000 active cooperative associations including information as to form of organization, management, membership, volume of business, financial status, and operating methods.

The biweekly circular, Agricultural Cooperation, was published during the year and carried material relating to the status and activities of cooperative organization among farmers. This source material is being used widely by association house organs, farm journals, and the general press. A

number of publications have been issued, including a 100-page bulletin presenting the historical development and present status of cooperative organization among farmers which was prepared from data collected from 10,803 active associations for the year 1925.

DIVISION OF FARM POPULATION AND RURAL LIFE

C. J. GALPIN, *in charge*

With the passage of the Purnell Act, 1925, legalizing expenditure of Federal funds for "such sociological investigations as have for their purpose the development and improvement of the rural home and rural life," new impetus has been given to studies of farm population and rural life. "Farm population" statistics are rapidly replacing in public print the unmeaning "rural population" figures. The "farmer's standard of living" has become a serious topic of interest. The "movement of population to and from farms" has not only gripped public attention but has become an important index of broad economic conditions, since the reports on farm population have become reliable and clear in meaning.

RESEARCH STUDIES

Thirty-five cooperative studies have been carried on during the past year in conjunction with State agencies. Thirteen of these have been made under the provisions of the Purnell Act, receiving the approval of the Office of Experiment Stations, and sharing in the benefits of the funds provided by this act. Undoubtedly, the use on the part of experiment stations of these increasing funds has made possible a more thorough-going type of research.

DIRECTORY OF TEACHERS IN RURAL SOCIOLOGY

The directory of persons teaching rural sociology in colleges and universities of the United States was issued October 1, 1926. Names of 615 teachers of rural sociology appear in the directory. This list is one of our active mailing lists.

NEW QUARTERLY PUBLICATION

A new quarterly publication was started during the year, entitled "Farm Population and Rural Life Activities," which is a review of current research and other related projects of this division and of institutions and agencies cooperating. This publication has proved to be very popular, the requests to be retained on the mailing list having come in 100 per cent.

MOVEMENTS OF POPULATION TO AND FROM FARMS

A survey of the movements of people to and from 25,000 farms in the United States indicates that during the calendar year 1926 there was a net loss of 649,000 persons from farms. After this survey 20,000 farm operators who had left farms for cities were circularized. A report on the character of these operators and the reasons for their leaving the farms has been prepared. Ten thousand farm operators who left cities for farms and are now farming were also circularized, and a report is being tabulated now on the character of these persons and the reasons for their movement to farms.

INSTITUTE OF METHODS OF RURAL SOCIAL RESEARCH

An institute at Purdue University was held April, 1927, for sociological research workers, to which this division contributed both by exhibits and by representatives at the institute. This institute indorsed the work of this division and requested more assistance for the various research workers at experiment stations in the States in planning and carrying out their research projects.

INTERNATIONAL COUNTRY LIFE CONFERENCE

The leader of this division was present at the International Country Life Conference in Brussels, Belgium, and represented officially there the United States Department of Agriculture. He also made a survey of country life research and living conditions in 13 countries of Europe over a period of six months, and was influential in bringing to this country the International Country Life Conference, which met at East Lansing, Mich., August 1, 1927. Considerable time has been spent with foreign embassies and legations in Washington in preparation for this conference.

FARMER'S STANDARD OF LIVING

Work is being done toward working out the principles governing the attainment and maintenance of a satisfactory standard of living on the farm.

The farmer needs expert assistance in planning for a wise expenditure of the rural community's money, as well as in the making of money. The masses in the cities have such experts on various lines of consumption and consequently spend their income to social advantage.

A study was completed during the past year on the farmer's standard of living which analyzed the living conditions of 2,886 white families of selected localites in 11 States. The results of this study were published and met with wide interest, reviews and special articles based upon the study being published by a large number of agricultural journals and other papers. Inquiries and comments received by the bureau indicated a need for much additional information along this line.

ECONOMICS LIBRARY

MARY G. LACY, *Librarian*

The library has continued to maintain broad contacts with workers in the field of agricultural economics, especially those of the agricultural colleges and State departments of agriculture, with other agricultural interests, other branches of the Government service, as well as with the general public. Active cooperation has been maintained with the Oklahoma Agricultural and Mechanical College and the University of California. Oklahoma detailed an employee to the library of this bureau, and California paid the salary of a person to work on indexes of the agricultural data relating to their respective States. It is possible that arrangements will be made with other States for similar work, which will be of value both to the States and to the Federal department.

In addition to preparing large volumes of material for the use of research workers in this bureau, much assistance is given to agricultural workers throughout the country in answering inquiries and supplying available data for their use. Of particular value to research workers are the bibliographies and selected lists of references which are prepared in the library.

A series of agricultural economics bibliographies is being published which covers a wide range of agricultural problems. These are meeting a very definite demand, as they furnish the research workers with a ready access to information relating to the problems upon which they are working. One of this series, prepared under the direction of the librarian, entitled "Price Fixing by Governments, 424 B. C.–1926 A. D.," received a national prize offered for the best bibliography in the field of agriculture and related sciences.

DIVISION OF LAND ECONOMICS

L. C. GRAY, *in Charge*

LAND RESOURCES AND LAND UTILIZATION

Study of the census returns on land utilization and work on the preparation of a report showing regional changes in land utilization since 1920 has been continued, and compilation of statistical data for a study of the trend of land utilization since 1880 by agricultural regions has been in progress.

The preparation of maps and other material relating to the classification and utilization of land in the Great Plains region is approaching completion. Field work required in the preparation of the natural vegetation and carrying capacity maps was completed in cooperation with the Bureau of Plant Industry. A large map showing the distribution in detail of crop, pasture, and forest land in the United States was prepared for the Sesqui-Centennial Exposition. A detailed soil map of the United States has been completed, in cooperation with the Bureau of Soils, for publication in the Atlas of American Agriculture issued by this bureau.

Surveys of settlers' progress and land utilization in sample areas of the southern Great Plains were completed, and work was continued on a study of the cut-over portion of the Great Lakes States. Studies of the trend of consumption of agricultural products in relation to the probable future need for crop land are in progress.

REGIONAL PLANNING STUDIES

A series of regional planning studies in regions of indeterminate land utilization have been initiated with a view to determining what lands should be used for crops, for pastures, and for forests; and to indicate what policies, public and private, will promote the most effective utilization of the land. Field work in two of these studies, one in northwestern Colorado and the other in West Virginia, is being carried on during the summer of 1927.

LAND SETTLEMENT AND RECLAMATION

As a result of field studies completed last year in cooperation with the Bureau of Public Roads to determine the economic limits of cost of water for irrigation, six additional preliminary reports of the studies of several projects covered have been issued. The final report covering these studies has been submitted for publication.

Field work on a study of the extent to which land in drainage enterprises has been brought into cultivation and is producing the means of meeting the obligations undertaken to cover cost of its reclamation, begun last year in cooperation with the Bureau of Public Roads, has been completed.

An important phase of the land-settlement work deals with methods used by States and private individuals and agencies in inducing settlement on lands that have not been used for agriculture. Studies have been made of the methods used by private land-settlement agencies in classifying the land offered for sale. This work also has for its purpose the development of methods that will promote definite policies of utilization for lands now unused or misused.

LAND TENURE

A study was made of the characteristics of all farms in the United States 1,000 acres and over, based on a first-hand tabulation of data available in the census schedules for 1925. The results of this study will show for the first time the size, distribution, location, and economic characteristics of such farms.

A report on the changes in farm ownership and tenancy for 1920 to 1925, based on an analysis of results of the census returns, was issued, and also two bulletins dealing with the ownership of rented farm land.

During the latter part of the year a study of land tenure in relation to land utilization was begun in middle Georgia, a region where a large number of farms have been abandoned and a large proportion of the crop land has gone out of cultivation. The study is designed to indicate what steps are requisite to the restoration of more nearly normal conditions in this region.

A study was also undertaken in order to determine the relationships between tenure, range control, and the utilization of land for grazing purposes. This project is based on the assumption that a policy for Federal public lands which would be suitable in one region of the West might not apply to conditions in other regions. It is designed to illustrate the diversity of conditions and consequent requirements as to policy.

LAND APPRAISAL AND LAND VALUES

A survey of conditions in the farmlands market was published for the first time as The Farm Real Estate Situation. By summarizing the available data on farm real estate values, earnings, taxes, "turnover" or volume and kind of transfers of title, including foreclosures, the publication aimed to give a basis indicative of trend and outlook to the owners of the country's 6,000,000 farms and to the various financial agencies directly concerned with farm real estate values. Response to the first report indicated that continuance of such an annual survey is needed.

Tabulation was begun of the cash rental data obtained by the 1925 census. These data, when summarized, will provide a significant index of the earnings of farm real estate and their relation to value for large areas of the country in which cash renting is common enough to serve as a representative measure of what a year's use of a farm is considered to be worth.

Studies of the effects of various local factors influencing farm land values have been continued in cooperation with the Bureau of Public Roads, with the object of developing methods of appraising land values as a guide to purchase and sale, assessment for taxation, and credit policies.

The analysis of long-time records of land prices from county sales records and other sources was continued. In these studies an attempt is made to measure the influence of various factors on the trend of such prices in selected farming areas.

A study of the effect of various local factors on land values in the cut-over counties of the three Lakes States is in progress in cooperation with the Minnesota Agricultural Experiment Station.

After a thorough study of all available data, an index of the value of farm real estate, taking improved farms as a unit and extending back to 1912, was prepared.

FARM LABOR

In order to obtain more adequate information concerning the perquisites received by farm laborers and the importance of such perquisites in supplementing farm wages and promoting

greater stability of employment, a questionnaire relating to casual farm hands was widely circulated. The returns supplement information concerning noncasual hands obtained the previous year. The results of these questionnaires are being prepared for publication.

Other studies now under way include agencies of distribution of farm labor in 12 Northeastern States, the farm labor supply and demand, farmers' methods of handling labor, and general farm-labor conditions in those States; monthly variations in amounts of family and hired labor on farms; statistical tabulation showing portion of farm population engaged as hired labor and the relation between the agriculturally employed population and the area of land and the value of farm property by census enumeration districts; and expenditures for farm labor and the part of production going to meet farm-labor expenses.

DIVISION OF ECONOMIC INFORMATION

J. Clyde Marquis, *in charge*

The critical changes in agriculture have created a remarkable demand for facts on the business and economic side of farming. This need for reliable statistics and interpretations has been growing since the agricultural depression, but not until the last year or two have agricultural and industrial agencies begun to turn to bureau information for the most accurate indication of the condition of the farm situation. This new demand necessitates constant changes to adapt the facts in character and form to the needs of those who use them and an increasing variety of publications is needed.

The general plan of economic information distribution of the bureau now involves, (1) immediate release as news; (2) complete copies of reports in mimeographed form; and (3) a final permanent publication in periodicals, bulletins, or the Yearbook of the department.

The press and radio are the outlets for this quick distribution of news. There follows immediately a call for the complete reports, however, and it is necessary to make them available as soon as possible for those who desire details regarding certain States and regions or classes of products. Such details are too lengthy to be included in the first brief reports. These reports are sent to special mailing lists. Finally, all reports are assembled into more permanent publications where they may be available for reference.

During the past year a plan of publication has been worked out to correlate the various forms of information into a chain of related forms which will make it easy for anyone to keep informed on the progress of agriculture. This chain includes the daily market and news releases, weekly and monthly reviews, weekly and monthly periodicals, annual bulletins and Yearbook statistics, and a series of comprehensive statistical bulletins which carry the figures back as far as available. Supplementing these publications, handbooks of wide variety have been planned and several are issued.

Along with means of rapid distribution, better forms of presentation have been developed in handling the material. The production of charts and graphs has been greatly increased, which has involved a large amount of drafting and reproduction in printed form. The use of charts and graphs by extension workers and farmers is growing steadily and few publications are considered complete until they have been fully illustrated by charts. Thousands of copies of charts made by bureau workers have been distributed during the year in the form of photographic prints, rotoprints, and in mimeographed charts. Equipment has been installed to increase greatly this form of distribution during the next year.

Through the economic chart service two lines of development are being pushed. First, charts of an historical nature showing price changes for a number of years, changes in production, movements, storage, and prices are being made and assembled in series by commodities. These charts can be easily kept up to date from current sources by those who use them so that this chart work will not need to be repeated frequently. Another series will deal with the price situations on a shorter time period, showing several factors in relation to each other to the end of illustrating the interrelation of various factors and how they affect prices. The photographic chart service has been conducted on a cost basis, nominal charges being made for quantities of prints as ordered.

PRESS AND PUBLIC CONTACTS

With the growth of news-distributing agencies more and more of the press releases of the bureau are handled through correspondents who visit the bureau daily to gather the information. Many of these agencies now maintain constant contact with the bureau and give special attention to

preparing their own exclusive articles on subjects in which they are interested. These articles are frequently adapted to the particular locality in which the subject is of special interest and are distributed quickly by wire by the special correspondents. Regular distribution of press releases has continued, as in the past, with some increase in number, although the individual articles have been condensed to conform with the growing pressure upon the space in the newspapers.

The preparation of regular market articles for farm papers and newspapers by members of our staff has been considerably increased during the year, and the distribution of these articles amounts to many millions in trade and economic journals. Sixty-one special signed articles were prepared by specialists of the bureau staff and accepted for publication in outside periodicals. Of these, 15 were written by the bulletin editor of the bureau and several others by members of the staff of the division.

Through contacts with special writers and correspondents and Washington representatives of various agricultural organizations, many articles have been outlined and material provided which has resulted in a wide distribution of bureau information. Many commercial and agricultural organizations send their representatives regularly to the division to secure facts by conference, which gives further distribution to crop and market information through the house organs of these agencies.

RADIO MARKET NEWS SERVICE

The use of radio as a means of distributing spot market news as well as general educational information on crops and markets has been extended during the year. Additional funds made possible the extension of the leased wire to Ames, Iowa, on July 1, 1926, where an extensive program of market news broadcasting was begun by station WOI at the Iowa State College. The college provides a market news editor and announcer and has been able to provide the producers of that State a very complete and quick service.

A similar market news broadcasting program was set up at Oklahoma City in cooperation with the State market commission and radio station KFJF. A drop of the leased wire was installed, providing at that office all the information available on the southwestern branch of the Federal system. The opening of new livestock market news offices in Buffalo, Cleveland, Pittsburgh, Cincinnati, and Indianapolis has greatly strengthened the service to livestock men in the Central States area.

The rearrangement of radio matters by the Federal Radio Commission made but slight changes in the general broadcasting of market news. The commission gave careful attention to the special needs of stations that were serving the agricultural industry and in several instances authorized changes in wave length and power to facilitate this work. The most complete voluntary cooperation has been received from almost all of the private broadcasting stations which generally recognize the service value of this information to producers and the trade. Late in the year the closing of station KFKX at Hastings, Nebr., deprived some producers of radio reports, but station KMMJ at Clay Center then volunteered to take over this service, and this to some extent has replaced the station formerly operated at Hastings. The drop of the leased wire was removed from Hastings to Clay Center to provide the reports. A canvass of listeners to these stations gives indisputable evidence of the value of radio market reports in that territory. Through conferences with representatives of several of the larger stations programs have been revised and enlarged, and plans have been made for a more complete market schedule to be inaugurated in the fall.

A survey of the number of radio sets on farms made through county agricultural agents in cooperation with the department radio service and the extension service early in the year showed that the estimated number of radio sets on farms had more than doubled since 1925, increasing from an estimate of 553,000 sets on farms in 1925 to 1,252,000 sets on farms in 1927.

The bureau has contributed economic material regularly to the farm radio school conducted by the department, including summaries of various crop situations, economic discussions by specialists on many subjects, and brief news items on the development of the crops, changes in market requirements, standards, and prices.

PERMANENT ECONOMIC PUBLICATIONS

The output of the bureau in the form of permanent bulletins and circulars of

a technical nature has exceeded any previous year by 14 titles. The largest increase was in department bulletins, of which 25 were issued compared with 16 the previous year. Several of the newer series of economic bulletins have been materially increased, the series of statistical bulletins having increased from 13 to 20, including a series of five price bulletins.

In addition to the printed reports of results of bureau work 36 preliminary reports have been issued and 67 miscellaneous reports and papers have been completed.

ECONOMIC PERIODICALS

The regular periodical has been found to be one of the best means of distributing economic information. Crops and Markets, a monthly statistical summary of the crop and market information gathered by the bureau, is now the principal periodical of the department for a permanent record of its work. With the end of December, 1926, the weekly edition of Crops and Markets was discontinued, since it had largely been replaced by other quicker forms of distribution, and the delays in printing and distributing it rendered a printed form of little value. Most of the material which formerly appeared in this weekly is now assembled into monthly tables, which appear in the monthly Crops and Markets.

For extension workers The Agricultural Situation was changed to a printed publication in January, 1927, issued by the department, and a subscription price of 25 cents per year was placed upon the periodical for those not cooperating with the department. This form places this valuable material in more compact and convenient form for ready reference. The mimeographed periodical, State and Federal Marketing Activities, has been continued for the benefit of State and Federal workers in this field. Foreign Crops and Markets is issued weekly, containing summaries of information from foreign sources. Agricultural Cooperation is issued semimonthly, carrying the news of progress and the development and changes in cooperative marketing and related lines.

A new mimeographed quarterly, Farm Population and Rural Life, was begun this year to provide a means of distributing summaries of the work in this field to the growing numbers of technical workers which has resulted from the increase in research projects under the Purnell Act. Agricultural Economics Literature, which was formerly a supplement to the Bureau of Agricultural Economics News, has been published as a separate monthly since January, 1927. This provides a very useful and comprehensive reference source to new literature on this growing subject.

ECONOMIC EXHIBITS

The bureau has contributed more extensively than in the past to the preparation of exhibits of its work, distributed through the department office of exhibits. An extensive display of bureau work was prepared for the Sesquicentennial Exhibition at Philadelphia, and the display was maintained from July to December. This exhibit was then dismantled, and many of the materials have since been shown elsewhere. The bureau participated in the National Dairy Exposition at Detroit by providing materials for 6 out of 15 units shown by the department. At the International Livestock Exhibition a number of displays were presented, including several new features. Bureau material was included in several of the fair circuit exhibits in the Central States.

A new form of small, portable display material has been developed and is being reproduced for distribution to meetings of producers of various commodities. Special displays were prepared for the American Farm Bureau Federation exposition at Chicago in December and for several other interstate meetings.

An increasing number of visiting groups of producers and the trade, including representatives of the dairy industry, cotton industry, etc., have required the preparation of special displays in Washington to present the work of the bureau in condensed, graphic form. Delegations of business men, the Pan American Standardization Conference, the national encampment of 4–H club boys and girls, and the visit of delegates to the World's Poultry Congress were instances of this character.

MOTION PICTURES AND SLIDES

Two new motion-picture films were completed this year and added to the 22 previously made on the work of the bureau. These films were Cooperative Marketing in the United States, and A New Method of Harvesting Cotton. Scenarios of four other films have been written and some of the work of production begun.

Several series of lantern slides have been completed and reduced to film strips for use in the small film projectors by lecturers. This form of pictorial material is found to be very useful in extension work, and many subjects will be reproduced in this form in the future.

PHOTOGRAPHIC LABORATORY

The increased use of charts and other photographic material has increased the demands upon the photographic laboratory, which have been met by increasing the facilities of this unit by the addition of more modern appliances. Enlarging apparatus, rotoprint-making equipment and film-slide instruments have been added. This unit has also contributed materially to the preparation of exhibit materials in the form of painting in color, photographic tinting, and enlarging.

U. S GOVERNMENT PRINTING OFFICE: 1927

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., August 30, 1927.

SIR: I have the honor to transmit herewith a report of the operations of the Bureau of Animal Industry for the fiscal year ended June 30, 1927.

Respectfully,

JOHN R. MOHLER,
Chief of Bureau.

Hon. W. M. JARDINE,
Secretary of Agriculture.

LIVESTOCK WORK OF SPECIAL PROMINENCE

The year covered by this report was marked by material progress in the betterment of the Nation's livestock industry through disease control and new knowledge on methods of production. No serious foreign livestock malady gained entrance to the United States, and the bureau was able to devote its full energy to regular experimental projects, research problems, inspection work, and control of diseases. Many of these activities are highly technical, requiring detailed discussions of methods and data for clear understanding. Results of such studies, accordingly, are published chiefly in technical bulletins or in the department's Journal of Agricultural Research.

This report, therefore, presents briefly the results of work having general public interest. By reason of their close relation to human welfare or current agricultural problems, several activities are of particular interest.

FURTHER PROGRESS IN ERADICATING TUBERCULOSIS

The cooperative campaign to eradicate tuberculosis from domestic livestock made excellent progress during the year. Public sentiment has supported this work so strongly that the Federal appropriation of $4,653,000 was supplemented by combined State appropriations of approximately $13,000,000. These funds made possible a large gain in the number of cattle tested, being more than 9,700,000, or about 7 per cent over the preceding year.

An especially noteworthy result was the increase in number of counties which completed the testing of cattle within their borders and had reduced the extent of infection to within one-half of 1 per cent. At the end of the fiscal year 347 such counties were officially recognized as being virtually free from bovine tuberculosis. This figure represents an increase of 149 counties over the number at the end of the previous year.

The eradication of tuberculosis from swine and fowls received increased attention. A survey conducted during the year and conferences with poultry specialists showed a need for aggressive measures in combating avian tuberculosis, which is readily transmissible to swine.

Results of the year's work showed also that tuberculosis of fowls can not be detected with assurance by physical examination, and that the tuberculin test, as in the case of bovine tuberculosis, is needed to detect diseased birds.

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EXCLUSION OF FOREIGN MALADIES REQUIRES CONSTANT VIGILANCE

Another year has elapsed without the recurrence of either foot-and-mouth disease or European fowl pest, two maladies which have been serious national menaces, as discussed in last year's report. Precautionary measures against these foreign diseases involved special inspections and investigations. On several occasions bureau inspectors investigated reported outbreaks of European fowl pest, but the ailments proved to be less serious diseases.

The report of the department's foot-and-mouth disease commission, which made special investigations in Europe, shows the need for continued vigilance by all persons concerned with the livestock industry of the United States. Extensive commerce, tourist travel, and other possible carriers of the infection make the exclusion of the malady difficult even with the strict quarantine measures now in force. The regulations were recently strengthened with respect to imports of scrap bagging.

The bureau has continued the practice of carefully inspecting all ruminants and swine received at public stockyards. Such inspections are made by veterinarians experienced in detecting foot-and-mouth disease so that no delay will occur in taking necessary control and eradication measures should the infection be found. The experience of foreign countries confirms the value of the quarantine and slaughter policy as practiced by the United States in eradicating foot-and-mouth disease on the few occasions it has gained entrance to this country. Foreign experience also shows the inability of eradicating the disease entirely, once it has become well established. Any tendency to temporize with this malady or to minimize its danger, therefore, is certain to be costly and may impose a permanent burden on the livestock industry and the Nation. The utmost cooperation in excluding and combating foot-and-mouth disease therefore is earnestly requested so that the United States—which is one of the few countries still free from the disease—may continue to enjoy freedom from this plague.

SURVEY OF ANIMAL PARASITES UNDERTAKEN

A study of animal parasites in the South has disclosed facts of both scientific and practical interest. In the case of the swine-sanitation system, developed in Illinois for controlling roundworms and other internal parasites of hogs, results obtained in southern Georgia have been highly promising. Cooperative work there with farmers who raised pigs under the sanitation system resulted in reduced losses and more rapid gains of pigs than were ordinarily experienced in that locality.

The results of a survey of parasites of livestock in Central America indicate that internal parasites there interfere but little with range livestock production. Apparently there is slight danger to the livestock industry in the United States from that source. During the last fiscal year a general survey of parasites in North America was undertaken. Data that are being obtained in connection with this important study show more definitely than has been known in the past the extent of livestock parasites, some of which are highly important from the standpoint of animal production.

RECORD PRODUCTION OF SERUM CHECKS HOG-CHOLERA OUTBREAKS

Under the provisions of the virus-serum-toxin act of 1913, the bureau continued to supervise the production of veterinary biological products intended for sale in interstate commerce. Owing to an unusual prevalence of hog cholera during the fall and winter of 1926, the production of anti-hog-cholera serum and hog-cholera virus in licensed establishments was exceedingly large. The output of serum considerably exceeded a billion cubic centimeters, which was more than twice as great as during the preceding year and approximately 50 per cent more than in any previous year. The output of hog-cholera virus was in corresponding proportion.

Owing to the emergency which existed for controlling the serious outbreaks of hog cholera, the release of untested serum was authorized for a temporary period, provided it was labeled to show that it had not been tested, such serum, however, having been made under close supervision. The final control of the outbreaks of hog cholera showed the effectiveness of the preventive-serum treatment and also the need for placing primary reliance on this method of preventing heavy losses from hog cholera. Most of the deaths of hogs from cholera occurred in herds whose owners had failed to take the precaution of immunizing them.

FLOOD WATERS AID TICK ERADICATION

The steady progress of eradicating cattle ticks from Southern States, dis-

cussed in previous reports, continued during the year just closed. Of the 985 counties quarantined when tick eradication began, July 1, 1906, a total of 737 have been released, leaving 248 still under quarantine on June 30, 1927. There was a net gain, during the year, of 12 entire counties and five parts of counties released from the domination of the cattle tick.

The principal progress occurred in Texas, Arkansas, Virginia, and Florida. Of the total 737 released counties 641 are entirely free of ticks, while in the remainder a few premises are held under local quarantine pending the eradication of the last ticks.

The economic cloud resulting from floods occurring in the Mississippi Valley during the fiscal year had a silver lining from a tick-eradication standpoint. Flood waters with accompanying deposits of silt destroyed the ticks throughout large areas, particularly in Louisiana. Such areas when restocked with tick-free cattle may be confidently expected to remain free of these destructive parasites. Accordingly, the bureau has urged that every possible advantage be taken of this unusual opportunity to advance the completion of tick-eradication work. The expense in such cases is a small fraction of the customary procedure when dipping vats must be built and maintained. Bureau inspectors in charge of field stations offered assistance in this undertaking to restock flooded area with tick-free cattle exclusively, though it is still too early to measure progress that can be attributed to the flood.

In a few instances the necessity of saving livestock in inundated sections resulted in the movement of some tick-infested animals to free areas, but no material spread of the parasites from such movement has been reported.

ANIMAL HUSBANDRY INVESTIGATIONS

Animal-husbandry investigations have continued to include important basic problems in breeding, feeding, and management of the principal kinds of domestic livestock. In addition several special investigations relating to meats, wool, mohair, and other important products of animal origin have yielded results of value to both producers and consumers.

In the meat investigations, conducted in cooperation with two other bureaus of the department, 25 State experiment stations, and other agencies, a total of 1,000 cattle were used. More than 150 of these were slaughtered at the United States Animal Husbandry Experiment Farm and were used in detailed studies of meat, including physical and chemical analyses, cooking, and palatability tests.

Cooperative investigations dealing with an oily condition of hog carcasses, known as soft pork, resulted in additional data showing how methods of feeding may overcome that condition. For instance, when peanuts, an oily feed, are fed to young pigs, the subsequent feeding of corn and tankage will cause the meat to acquire satisfactory firmness.

Experiment farms conducted by the bureau in various parts of the country for the study of special problems continue to be of service to livestock owners in those regions. At the larger farms annual field days enable stockmen of the locality to study the work at the farms and obtain the most recent results. In other cases the assistance is rendered at any time applicants may visit the station or request aid by correspondence.

In the production of range sheep in the intermountain region the United States Sheep Experiment Station at Dubois, Idaho, has found climate to be a very important factor. Varying quantities of rainfall greatly affect the carrying capacity of sheep ranges, resulting in available forage fluctuating from 25 per cent below normal to 35 per cent above.

OTHER RESEARCH WORK

Investigations of chemical and biological nature yielded results of scientific interest with promise of useful application. The chemical structure of several disinfectants was shown to have a definite ratio to their bactericidal efficiencies.

Studies of tuberculin disclosed two biologically active principles in this valuable diagnostic agent. This discovery has a direct bearing on methods of preparing and testing tuberculin and promises to result in better methods of producing it and to insure a more uniform and standard product. The importance of these findings is apparent in view of the extensive use of the product in tuberculosis-eradication work.

In the study of infectious diseases of livestock, results of the year's investigations show the continued need for a method of immunizing livestock, especially cattle, against infectious abortion. The stealthy character of the disease and uncertainty regarding the time when an apparently healthy animal may disseminate the infective organisms make the control of bovine infectious abortion by sanitary meas-

ures alone very difficult. Besides, special facilities are needed and the thorough precautions involve considerable expense. Experiments have been continued accordingly with the hope of producing a method of immunization that can be practiced on farms where detailed sanitary control measures are not economically practicable.

There are some grounds for optimism in recent experiments seeking to control infectious abortion by calfhood vaccination. The results indicate that such vaccination may confer immunity as effective as the vaccination of heifers slightly before breeding. Treatment of animals as calves considerably simplifies herd management, especially when owners do not maintain accurate records of breeding.

WORLD SURVEY ON LIVESTOCK IMPROVEMENT

Owing to the international phases of the production of meats and other animal products, as well as prestige in the possession of high-quality herds and flocks, the bureau conducted a world survey on this question. Reports obtained through the consular service and from representatives of the Bureau of Agricultural Economics have shown that the subject of improved livestock is receiving the attention of the principal stock-producing countries of the world.

Many of them have passed legislation which in some cases is virtually a subsidy to encourage and finance the placing of purebred sires at advantageous points for the convenience of livestock owners. In other cases foreign governments have actively sponsored important livestock exhibitions to stimulate rivalry in the development of superior animals. The widely varying methods and meager definite data as to their results make comparisons difficult. But in general the status of livestock-improvement work in the United States compares favorably with that of other countries in its extent, results, economy of administration, and permanent influence. The bureau has continued an active campaign to encourage the use of purebred sires in all classes of livestock. Farmers and stockmen participating in this work at the close of the year number 17,106.

PERSONNEL

On June 30, 1926, the bureau rolls contained the names of 4,045 employees, including both the Washington and the field forces. During the fiscal year 573 new appointments were made, 10 employees were transferred from other bureaus or departments, and 42 former eligibles were reinstated, making 625 additions to the bureau personnel.

During the year 599 employees were separated from the service, 209 by resignation, 27 by death, 16 by transfer to other bureaus or departments, 21 by removal for cause, 20 were retired under the provisions of the retirement act of May 22, 1920, and other separations numbered 306. Outside of the few classified employes who failed to report for duty, necessitating revocation of the appointments, this last class of separations is entirely composed of unclassified temporary employees, such as agents in tick eradication, unskilled laborers, etc., whose services are needed only for seasonal employment.

At the close of the fiscal year the bureau personnel numbered 4,071, an increase of 26 over the previous fiscal year.

VETERINARY EDUCATION

One of the accredited veterinary colleges ceased operation during the fiscal year, making the present number 12 whose graduates are eligible to participate in civil-service examinations for bureau positions. The number of foreign veterinary colleges on the accredited list is 10, the same as the previous year.

The number of freshmen registered at all the accredited colleges in the United States and the one in Canada during the year was 193, as compared with 165 the previous year; and the total student enrollment was 606, an increase of 24 over the school year of 1925–26. The number of veterinary graduates was 115, or 17 less than the previous school year. However, the increase in student attendance at all the veterinary colleges during the school year 1926–27 gives rise to the hope that veterinary education is presenting a stronger appeal than in recent years to the young men of our country.

Owing to the constant need of the bureau for qualified veterinarians, special study of the veterinary situation was made. The results showed a marked shortage, in the bureau's service, of veterinarians under 30 years of age. The average age was considerably over 40 years. This condition foreshadows a rather large number of separations within the next few years owing to retirement and other causes that accompany advancing years. Un-

der normal conditions in the service approximately 100 new veterinary appointees are needed annually, this number being only slightly less than the total number of graduates, this year, from all veterinary colleges in the United States.

In view of the requirements also of State, county, and municipal governments and opportunities in private practice, it is clear that the veterinary field holds ample opportunity for well-trained young men. Salaries for veterinarians in the bureau's service are somewhat higher than in recent years, and special efforts have been made, from a salary standpoint, to recognize professional skill and executive ability.

LITERATURE, EXHIBITS, AND MOTION PICTURES

Publications prepared by the bureau during the year included 138 new and revised documents, a material increase over the previous year. Contributions to the various series of publications included 39 farmers' bulletins, 3 department bulletins, 6 department circulars, 13 issues of Service and Regulatory Announcements (including the index), 2 department leaflets, 7 articles for the Journal of Agricultural Research, 28 orders of regulatory character, 22 yearbook papers, 4 posters, 6 miscellaneous publications, and 8 booklets prepared for the department's radio service.

The bureau furnished the press service of the department with articles, news material, and other items for publication to the number of approximately 100, besides which a similar volume of contributions was made to the radio service for broadcast purposes. In cooperation with the office of exhibits of the department specialists of the bureau designed and prepared special displays for the International Livestock Exposition, the World's Poultry Congress, and numerous smaller events. Exhibit material prepared in the bureau was also shown on State fair circuits, as usual.

The bureau has continued to cooperate with the department's office of motion pictures in preparing scenarios and in directing the making of pictures from a subject-matter standpoint. The series of available lantern slides, charts, and other pictorial matter was materially increased during the year.

The year's work as conducted by the various divisions of the bureau is presented more fully in the following pages.

ANIMAL HUSBANDRY DIVISION

The work of the Animal Husbandry Division, consisting chiefly of research in animal husbandry, including poultry husbandry, was conducted under the direction of E. W. Sheets, chief.

ANIMAL GENETICS

Investigations in genetics were confined largely to studies of the effects of inbreeding. Five inbred lines of guinea pigs were continued and an effort made to expand each line to a point where the surplus stock will furnish sufficient material for the conduct of experiments which require stock of known ancestry and free from genetic variation.

The study of the abnormality known as otocephaly assumed increased importance during the year, due to the fact that a subline of one of the inbred families of guinea pigs has produced in excess of 20 per cent of this type of monstrosity. Specimens were also obtained of otocephalic swine and lambs from the stock maintained at the bureau's farm, Beltsville, Md.

The inbreeding experiment with swine made considerable progress during the year. It was found possible to discard the foundation animals and to replace them with first-generation stock from brother-sister matings. This made possible a notable increase in the number of sows bred for second and third generation litters. The analysis of data compiled to date indicates that the generalizations reached in the guinea-pig inbreeding project will also be reached in the swine inbreeding project if it is carried on long enough. A study of the data on 364 first-generation pigs shows that some lines run out almost immediately while others seem to maintain their vigor. It was found that on the average one generation of brother-sister mating did not have a significant effect on either the birth weights or the weaning weights of the pigs. There was a slightly higher proportion of dead or weak pigs at birth among the first-generation inbreds than among the controls. The percentage raised to weaning of all pigs born was lower among the inbreds. Data on the second-generation brother-sister mating indicate a much greater deleterious effect of inbreeding in most lines. A notable exception is a line of Tamworths in which the second-generation pigs were superior to the controls with respect to birth weight, weaning weight, and type.

ANIMAL NUTRITION

In the nutrition laboratory, refractive indexes were determined on samples of fat taken from 1,350 hogs. In relation to fat, experiments were carried out as follows:

Fatty-acid separations were made on 13 animals in an experiment to study the value of brewers' rice on the nature of fat deposited by the hog; the quantity and composition of fat formed in hogs started at 40 pounds' weight and fed peanuts 8 weeks, and then corn for a maximum of 20 weeks; fatty-acid composition of the fat from hogs fed rice bran and rice polish, alone, or followed by corn or brewers' rice; the determination of the effects of cottonseed oil on the composition of lard; refractive indexes have been made of the fats of 100 lambs, in connection with sheep investigations and of the beef ribs in the cooperative quality-of-meat project.

During the year the nutrition laboratory analyzed "eye" muscle and the remaining edible portion of 165 ribs of beef from 19 State stations, and performed a complete analysis of 6 lamb carcasses.

Studies have been in progress on the protein requirements of laying hens and growing chicks and in factors affecting molting.

COOPERATIVE EXTENSION

Further improvement in the general livestock situation was reflected by extension activities during the year. A larger share of attention was given to fundamental problems and long-time constructive projects than had been possible since the beginning of the period of agricultural depression in 1920.

Big-team hitch demonstrations were widely used by extension agencies as an entering wedge to the problems of horse husbandry, which are now receiving increased attention.

The consumer preference for lightweight cuts of quality beef had a marked influence on beef-cattle-production activities in the range States as well as in the larger finishing areas of the Corn Belt, the aim being to produce prime beef at younger ages. Beef-calf club work, having pioneered in this field for several years, must be given credit for a share in developing the demand for the product called "baby beef."

The docking and castration of market lambs, the use of purebred rams, the control of stomach worms, and better feeding of both ewes and lambs were the main points stressed in farm sheep work.

Swine-sanitation projects, based on the research work conducted by the bureau on the control of the internal parasites of hogs, occupied a large place in the activities tending to improve the efficiency in pork production. Ton-litter work continued to expand during the year, as 808 official ton-litters were reported, compared to 767 last year, the previous high mark.

In work with poultry the year's reports show the continuation of an improvement in methods of conducting the work as well as in the application of new facts in research. The culling of flocks still leads as the practice most widely adopted, though it is frequently connected with other projects.

On October 1, H. L. Shrader, formerly in charge of poultry extension work in Missouri, was appointed extension poultry husbandman for the department.

The quarterly publication entitled "The Extension Animal Husbandman," which is a house organ for animal husbandmen in extension work, was continued during the year.

MEAT INVESTIGATIONS

During the year there was active participation in the national cooperating project, "A study of the factors which influence the quality and palatability of meat." The importance of the project and the extent of the interest in it are shown by the fact that, in addition to three bureaus of the department and other agencies, 25 State stations took part in the work.

From the beginning it has been known that the project involved two distinct phases. There were no established methods for measuring and expressing variations in the quality and palatability of meat. Thus the formulation of such methods constitutes one phase. The other and principal phase is the determination and measurement of the influence of the different factors which affect quality and palatability.

Cattle and beef have been regarded as of primary importance in this broad project. Some of the important questions are the causes of dark cutting beef, the relative palatability of grass-fattened and grain-fattened beef, and the relation of age, sex, breeding, and feed to the quality and palatability of the product. Although the principal study has been with cattle and beef, a considerable amount of work has been done with lambs and

lamb meat, and a beginning has been made on hogs and pork.

During the year approximately 1,000 cattle were fed out at the various stations in connection with this project. A total of 153 head of these cattle were shipped to the United States Animal Husbandry Experiment Farm at Beltsville, Md., for slaughter. Detailed laboratory, cooking, and palatability studies were made on rib samples from lot representatives of these cattle, as well as on samples from a number of cattle slaughtered at central markets. Detailed studies were made on a total of 165 pairs of beef ribs during the year. These observations included physical and chemical analyses, color readings, histological examinations, mechanical tests for tenderness, photographs and tracings, as well as cooking tests and palatability judging and grading. Expense and lack of facilities have limited these studies to representative animals or carcasses.

Another important step in the performance of quality-in-meat experiments is the grading of the animals and their carcasses. In the beef work all the cattle fed at the different cooperating stations were graded in detail as feeders, as slaughter cattle, and in the carcasses. This work was done by a committee of three, consisting of one representative each of the cooperating State stations, the Bureau of Agricultural Economics, and the Bureau of Animal Industry. All the lambs slaughtered at Beltsville, Md., were graded on foot just prior to slaughter and in the carcasses after chilling.

A total of 481 lambs were slaughtered at Beltsville in connection with quality-in-meat experiments. Complete records, including judging of palatability, were made on 200 of these. The principal factors involved were feed, breed, and castration.

In the two years' time since experimental work was actually begun on this project a marked refinement in methods has been accomplished, making possible the measurement of distinct differences in the quality and palatability of meat. The data obtained from the detailed studies of the standard meat samples and from the gradings of the animals and carcasses are being correlated with other items, including age, sex, breeding, feed, and the weights and gains of the animals.

The soft-pork project which is being conducted in cooperation with State experiment stations and swine breeding and feeding projects in progress at Beltsville furnished 1,278 hogs for slaughter at that station. Seventy-seven shipments of meat and experimental animals were sent to the laboratory by 19 stations, in addition to the animals owned and fed by the department.

The sales of surplus and salvaged products from this meat totaled $49,531.26, of which $35,583.15 was returned to the cooperating State experiment stations, and $13,948.11 was received from Government-owned products.

BEEF-CATTLE INVESTIGATIONS

Investigations in the production, wintering, and fattening of beef cattle were conducted in the Appalachian region, in the Corn Belt, in the Cotton Belt, and in the range areas of the West, Northwest, and Southwest, in cooperation with State experiment stations. The Bureau of Agricultural Economics, the Bureau of Plant Industry, and the Forest Service of the department cooperated in some of these studies.

INVESTIGATIONS IN THE APPALACHIAN REGION

An experiment begun in December, 1925, to compare the economical wintering of two distinct market grades of steers and the effect of grain as a supplement to summer pasture on the the quality of meat produced by both grades of steers is being continued. The cattle carried through the winter 1925–26 were marketed in the latter part of August, 1926, at Jersey City. The cattle receiving a supplement of grain on grass sold for $1 per hundredweight over the straight grass cattle. The good grade steers sold for 60 cents a hundredweight over the medium grade. Complete results will not be available until three years' work is completed in the fall of 1928.

A two-year study to determine the merits of various methods of handling and fattening steers in southwestern Virginia has been completed. The data are being compiled for publication. An experiment to determine the value of a grain supplement to grass as compared to grass alone and to dry-lot feeding, is being continued at Blacksburg, Va.

A Milking Shorthorn herd at the United States Morgan Horse Farm, Middlebury, Vt., is being developed to study the merits of individual animals and of the breed for the Appalachian region.

INVESTIGATIONS IN THE CORN BELT

An experiment to determine relative values of different methods of feeding beef calves before weaning and from weaning time to yearlings, begun at the Sni-a-Bar farms, Grain Valley, Mo., in May, 1925, was continued. Comparisons were made between calves allowed to run with their dams on grass without additional feed, calves with dams on grass and allowed grain fed within creeps, and calves kept on separate pasture from dams with access to grain and allowed to nurse twice daily.

At the end of the grazing season the calves are fattened in the dry lot on corn, linseed meal, and alfalfa hay. All lots receive the same type of ration. The effect of the method of handling previous to weaning time upon the feed-lot performance is determined.

This experiment will continue another year, making three years in all. Field-day meetings were held in the fall at the end of the grazing season and in the spring when the calves were ready to go to market. Mimeographed reports of progress were distributed on the field days.

INVESTIGATIONS IN THE COTTON BELT

A project begun in 1923 on 320 acres of cut-over, long-leaf pine land at McNeill, Miss., was continued to compare the effects of burning native pastures on the vegetation, the gains of cattle grazed on such pastures, and the reforestation which takes place.

The three-year project to compare the relation of feed consumed to the quantity and quality of meat produced by purebreds, grades with three-fourths and one-half pure blood, respectively, and scrubs, begun in June 1924, at Jonesboro, Ark., will terminate with the disposition of the present calf crop. The 1926 calf crop was fattened in the dry lot during the winter 1926–27 and marketed in April. The economy of gains and selling prices of the calves have been in favor of the better-bred calves.

Beef-cattle investigations at the Iberia Livestock Experiment Farm, Jeanerette, La., consisted of the fattening of Hereford and Brahman calves, and 2-year-old steers and heifers, during the winter. A three-year experiment to determine the relative value of various rice products in the fattening ration was completed in April. Results are now being prepared for publications. Brahman and Hereford calves produced on the station farm were fed out for the first time. Records have been kept of the beef herd, and growth studies made on Brahman and Hereford calves.

BEEF PRODUCTION IN THE RANGE AREA

A beef-cattle study was established in the northern Great Plains region, comprising adjoining localities in the States of North Dakota, South Dakota, Montana, and Wyoming, for the purpose of ascertaining the most satisfactory practices of range-cattle production and the most desirable size of ranch outfit.

Beef-cattle surveys were made during the year in western Texas, and in New Mexico, Arizona, and Utah. The material has been prepared for publication.

An experiment similar to that of previous years in wintering steers was carried on at Ardmore, S. Dak., to determine the effects of various methods of winter feeding on the gains made on pasture during the following grazing season. The results of this test are included in the annual report of the Ardmore station.

At the northern Montana substation located at Havre experiments to determine the relative values of alfalfa hay, corn fodder, and cottonseed cake, when fed with straw, in wintering rations for breeding cows duplicated the 1925–26 tests. Two-years' tests were made in comparing brush shelter with sheds for sheltering breeding cows. Cottonseed cake and alfalfa, when fed with straw, were compared in wintering rations for yearlings. Four years' tests, in which alfalfa and bluejoint hay were compared in wintering rations for calves, have been completed. Mimeographed preliminary reports covering all the work at this station were distributed at the field day, May 29, 1927.

At the United States Range Livestock Experiment Station, at Miles City, Mont., the breeding herd of beef cattle utilized the range so far as was possible for their winter feed. As the winter progressed the thinner cows were placed in the feed lots and fed corn silage, oat straw, and mixed hay. Corn fodder was used for a short period with one group of cows. Four lots of calves (65 head in all) were fed wintering rations, as follows: Alfalfa; alfalfa and cottonseed cake; alfalfa and corn silage; and alfalfa, cottonseed cake, and corn silage. Five lots of steers, comprising 49 head in all, were fattened in the dry lot. Rations having one-half and full allotments of barley with alfalfa hay, and also with

cottonseed cake in addition, were used. Two lots of yearling heifers, 21 head each, were wintered respectively on alfalfa and bluejoint hay.

A three-year experiment at Kingsville, Tex., in which Brahman crossbred steers were compared with Herefords and Shorthorns in feed-lot performance and killing qualities was completed, 100 head of steers being used each year. The data are being compiled for publication.

INVESTIGATIONS AT BELTSVILLE, MD.

A beef Shorthorn herd is being developed at the experiment farm, Beltsville, Md., and will be used as a basis for breeding and other experimental work.

BEEF-CATTLE INVESTIGATIONS CORRELATED WITH MEAT STUDIES

The projects dealing with the fattening of steers for market at Jeanerette, La., Kingsville, Tex., Grain Valley, Mo., Jonesboro, Ark., Blacksburg, Va., and Lewisburg, W. Va., have been linked with the cooperative meat project—a study of the factors influencing the quality and palatability of meat. The steers at these places have been graded and samples of meat analyzed according to the method of procedure outlined in the meat project.

SWINE INVESTIGATIONS

Swine investigations were continued at the experiment farm at Beltsville, Md., the Coastal Plain Experiment Station at McNeill, Miss., the Livestock Experiment Farm at Jeanerette, La., the United States Range Livestock Experiment Farm, Miles City, Mont., and at the Ardmore, S. Dak., Huntley, Mont., and Newell, S. Dak., stations of the Bureau of Plant Industry.

At McNeill, Miss., 19 sows were bred for fall (1926) litters, 12 of which farrowed 85 pigs and weaned 71. Thirty pigs which were fed on corn, tankage, mineral mixtures, and oats pasture and 32 pigs on identical feeds on carpet-grass pasture formed the test lots. The average daily gain of the grass-pasture lot was 0.92 pound per pig and of the oats-pasture lot 1.23 pounds per pig.

At Jeanerette, La., of the 10 sows which were bred for fall (1926) litters, 5 of them farrowed 48 pigs, of which 27 were weaned. Twenty-four of these were divided according to sex and weight into two equivalent lots for a comparison of shelled corn and brewers' rice. These were self-fed along with rice bran, rice polish, tankage, and mineral mixture. The average daily gain of the brewers'-rice lot was 1.29 pounds and that of the shelled corn lot 1.24 pounds.

Following serious results with abortions at Miles City, Mont., among the sows in the spring of 1926, an effort was made to produce all pigs from the sows which failed. Of the 21 sows bred, only 9 farrowed, producing 89 pigs of which 67 were weaned and 64 fed out for market. Twenty-five of the pigs were transferred to the beef-cattle department for use in following cattle, and later these were returned to the feed lot. The 64 pigs reached average weights of 211 pounds in 255 days on barley, tankage, alfalfa hay, and mineral mixture.

The herd at Miles City is made up principally of Yorkshire and Chester White purebred and crossbred hogs for comparison of types best suited for Wiltshire-side production. In conjunction with this work the cost of production of the two breeds and the crosses is determined for feeder-pig weights and for finished hogs.

The swine investigations conducted at the experiment farm at Beltsville, represent a larger field of activity with a larger number of breeds and more hogs than at any of the field stations. Two projects, the investigations relating to soft pork and the effects of inbreeding practices in swine, have consistently required most of the hogs raised at Beltsville.

The soft-pork investigations are conducted cooperatively with various State experiment stations, and at the annual meetings such conclusions as have been reached in the several phases of the experiment are determined and published. Additional conclusions which were released in May, 1927, are given herewith:

1. **Tentative conclusions subject to additional data.**—Pigs weighing less than 50 pounds initial weight, gaining approximately 20 to 60 pounds on peanuts, followed by a gain of 190 pounds on corn and tankage, have produced carcasses of a satisfactory degree of firmness in the usual case.

2. **Corn and soy beans, 6: 1 ratio, fed in dry lot.**—Pigs weighing 115 pounds or more and gaining at least 1.5 pounds a day on corn and soy beans, 6: 1 with mineral mixture in dry lot, through a period of 10 weeks or longer, have produced firm carcasses in the usual case.

3. Pigs weighing less than 90 pounds and gaining a maximum of 1 pound a day on corn and soy beans, 6: 1 with

mineral mixture in dry lot, through a period of 14 weeks or less, have produced soft carcasses in the usual case.

The results of the cooperative work with vitamin-deficient feeds on hogs including fall 1925 pigs are assembled and practically ready for publication.

Cooperative work with the Biochemic Division on the immunization of suckling pigs was continued at all of the field stations and at the Beltsville farm. The immediate effects of the treatment on suckling pigs, as shown in growth curves, was determined to and including fall pigs, totaling 2,378. There was slight evidence that pigs immunized in the early part of the suckling period make better gains than those treated toward weaning ages. Practical results show that no ill effects are produced by suckling-pig treatment.

SHEEP AND GOAT INVESTIGATIONS

One of the important accomplishments in sheep and goat investigations has been the development of an active and comprehensive program of cooperative research, conducted jointly by the bureau and several State experiment stations. This cooperative research covers studies in wool, mohair, mutton, and lamb.

FARM-SHEEP INVESTIGATIONS

Investigations of farm-sheep problems are conducted at Beltsville and College Park, Md., Middlebury, Vt., LaFayette, Ind., Newell, S. Dak., Havre, Mont., Hillsboro, W. Va., and at McNeill and Agricultural and Mechanical College, Miss.

The experiments at Beltsville consist of (1) the development of a practical system of forage-crop pastures for sheep, (2) effects of flushing (extra feeding at breeding time) on lamb yields, (3) growth in lambs and wool, and (4) type fixing of purebred sheep.

The forage-crop investigations involve the study of many crops and various methods of management. Progress on this project is reported in Farmers' Bulletin 1181, Raising Sheep on Temporary Pastures. Results to date show that forage can be used to an important advantage in providing good pasture for sheep throughout the summer and especially during periods of the growing season when permanent pastures fail. The flushing experiment was continued along lines similar to those followed in previous years, three lots being used. Lot 1 was flushed on good pasture and yielded 133.3 lambs per 100 ewes; lot 2 was unflushed and had 128.6 lambs per 100 ewes, while lot 3 was flushed with grain and had 123.5 lambs per 100 ewes. These figures show that the grain-flushed ewes produced the smallest percentage of lambs, pasture-flushed ewes the largest, and that the unflushed ewes yielded an intermediate percentage of lambs. These data also show that the lambing percentage for all the flushing-experiment ewes at Beltsville this year was only about the average of the yields of the unflushed ewes over the past decade, while this experiment has been in progress, and about 17 per cent below the average of the flushed lots of that period. The average results during the full period of the experiment, however, show a material advantage derived from flushing. The data of the last year show that the condition which tends to the production of twins in sheep is not always accomplished by providing extra feed during the breeding season. Furthermore, the greater yields from the pasture-flushed ewes are strictly in line with the trend of the results of this project for the last 11 years during which it has been in progress.

Studies in the growth of lambs are conducted by means of weekly weighings of all lambs, and biweekly measurements of representative lambs of the Southdown, Shropshire, and Hampshire breeds.

Type fixing of Southdown, Shropshire, Hampshire, and Corriedale sheep was conducted by the bureau's established method of selective breeding based on the detailed scoring system. About 350 sheep and lambs were maintained at Beltsville for this work.

The sheep studies at College Park, Md., are conducted in cooperation with the Maryland Agricultural Experiment Station. They consist of investigations of the influence of age, sex, and castration of lambs on the quality and palatability of lamb meat. Only one year of work, involving about 60 lambs, has been completed and much more data must be acquired before the facts can be definitely determined.

The Middlebury experiments include (1) the effect of flushing on lamb yields, (2) growth studies, (3) grading up farm sheep, and (4) a comparison of ram lambs with wether lambs as meat animals. The flushing experiment gave results consistent with those obtained at Beltsville. The unflushed ewes yielded 127.6 lambs per 100 ewes, while the ewes flushed with grain produced 118.2 lambs to

the hundred ewes. None of the Middlebury ewes were flushed with pasture. It will be noted that the pasture-flushed ewes at Beltsville yielded a larger lambing percentage than any of the other four lots of ewes at both the stations. Pasture is usually the cheapest, most practical and, according to the bureau's experiments, the most effective means of securing larger yields of lambs.

Growth studies at Middlebury were conducted by means of weekly weighings of all lambs, biweekly weighings of yearling and mature stock, and by means of annual weighings and monthly measurings of wool. Grading up was conducted by mating first, second, third, and fourth top-cross Shropshire and Southdown ewes with purebred rams of their respective breeds. This was the second year's work in the comparison of ram lambs with wether lambs. The results were consistent with those of the first year. The ram lambs were a trifle the larger but they were not so well finished as the wether lambs and did not dress out so well as the wethers. About 50 of these ram and wether lambs were used in a study of the quality of their meat. The sheep and lambs maintained for this work at Middlebury numbered about 250.

This was the second year for the sheep experiments that are conducted at LaFayette, Ind., in cooperation with Purdue University Agricultural Experiment Station. They consist of (1) fattening western range lambs and (2) production of market lambs under Corn-Belt conditions. Between October and January, 200 feeder lambs that were produced at the United States Sheep Experiment Station, Dubois, Idaho, were fattened at LaFayette and late in January they were all slaughtered at the bureau's experimental abattoir, Beltsville, where extensive records were obtained for each lamb. The studies in the quality and palatability of the meat from these lambs were conducted in cooperation with the Bureaus of Home Economics and Agricultural Economics. Studies in palatability were carried out in detail on 100 of the carcasses of these lambs.

This cooperation with the Purdue station includes the use of a flock of 125 choice, high-grade western Rambouillet ewes for lamb production under Corn-Belt conditions.

The sheep experiments at Newell, S. Dak., are conducted under the conditions of irrigation agriculture of the northern Great Plains section. They consist of studies in (1) pasture utilization with sheep, (2) sheep feeding, (3) lamb production, and (4) wool production. The pastures studied include alfalfa, sweet clover, and native range. The sheep-feeding studies apply to farm-flock maintenance. In lamb production a special study is in progress on the influence of age in ewes on their production of lambs.

Results in wool production show that it is possible to produce good wool with Hampshires under western irrigation conditions but that great care must be exercised in the selection of breeding stock in order to maintain satisfactory weights and quality in their fleeces. Range ewes with Merino or Rambouillet inheritance, kept in this same flock with the Hampshires, have sheared heavier and finer fleeces than the Hampshires, but the lambs from the Hampshire ewes weigh heavier at a given age than lambs from the native range ewes, so that under normal conditions, Hampshires seem well adapted and perhaps best adapted to irrigation-farming conditions. About 185 sheep and lambs are used at Newell.

At Havre about 70 sheep and lambs of the Rambouillet breed are used cooperatively with the Montana Agricultural Experiment Station in a study of sheep raising under conditions of dry-land agriculture on the northern Great Plains. Results indicate that Rambouillets are well adapted to the Havre region.

The sheep experiments at Hillsboro, W. Va., are carried on in cooperation with the West Virginia Agricultural Experiment Station. The work consists of a study of the influence of breed on the production of market lambs and the quality and palatability of their meat. A flock of 120 native West Virginia ewes has been permanently divided into four uniform lots of 30 ewes each. These ewes are chiefly grade Hampshires and they are being bred to rams of four different breeds—Southdown, Cheviot, Hampshire, and Shropshire—according to a systematic plan of mating for a period of four years ending in the fall of 1929.

The search for methods of effectively controlling internal parasites is still the primary activity in the sheep experiments at McNeill, Miss., in cooperation with the Zoological Division. Findings to date indicate that it requires about 10 acres or more per sheep, frequent changes of pasture, and a monthly medicinal treatment with a solution of 1 per cent copper sul-

phate and 1 per cent nicotine sulphate in water to be able to raise lambs to breeding age successfully. If sheep are to be raised economically in the McNeill locality it seems necessary to find a more successful method of controlling the internal parasites. A flock of about 185 ewes and lambs is maintained for the work.

The sheep experiment at Agricultural and Mechanical College, Miss., was a part of the cooperative project, "A study of factors which influence the quality and palatability of meat." Forty lambs were produced by the use of native and grade ewes and purebred Southdown rams. These lambs and their mothers were divided into two uniform lots containing 20 lambs each. The lambs of lot 1 were fed a grain mixture of corn, oats, and bran, and were grazed on pasture with their mothers. The lambs of lot 2 were grown with their mothers on pasture only. These lambs were born in December and January, and were shipped to Beltsville about June 1, where they were used in detailed meat studies.

RANGE-SHEEP INVESTIGATIONS

The range-sheep industry of the intermountain region continues to have the services of the United States Sheep Experiment Station near Dubois, Idaho; the northern Great Plains country is served by appropriate range-sheep investigations of the United States Range Livestock Experiment Station at Miles City, Mont., and at the south end of the Great Plains country on the Edwards Plateau the bureau is cooperating with the Texas Agricultural Station in a study of the comparative adaptability of Rambouillet and Corriedale sheep to the plateau ranges.

The program at Dubois includes four primary projects, viz: (1) Range utilization, (2) wool production, (3) lamb production, and (4) sheep breeding. The Forest Service is cooperating with the bureau in the studies of range use. This work is conducted on the typical spring-fall sagebrush range of the sheep-station lands. The principal areas for these studies of the use of range vegetation consist of 10 fenced paddocks, 9 of which cover 80 acres each and 1 measures 240 acres. Several other pastures or subdivisions of the station's grazing lands have been fenced in such a way that they are also being used in this study.

Following are some of the more important range studies now in progress: (1) The effect of climate on range-forage production and carrying capacity; (2) the early spring-grazing problem; (3) improvement of range that is more or less depleted; (4) the forage value of range plants, and (5) carrying capacity.

Climate is a very important factor in range-sheep production. At Dubois the precipitation was about normal, or 12.61 inches in the year 1923; the year 1924 was very dry, with a rainfall of 7.56 inches; 1925 was wetter than average, having a rainfall of 16.54 inches, and 1926 was very dry, with a rainfall of 8.78 inches. Weather Bureau stations within a radius of 90 miles of the sheep station show that for a long period of years the mean rainfall of the region was 12.39 inches. The carrying capacity of the sheep-station ranges was greatly affected by these great differences in annual precipitation. Station records show that the sheep-carrying capacity of these ranges was 21 per cent below normal in 1924, 35 per cent above normal in 1925, and 25 per cent below normal in 1926. This wide variation in the size of the range-forage crop fluctuating from 25 per cent below to 35 per cent above normal emphasizes the importance of considering the factor of climate in the study of management of range use. The practice of conservative stocking has made it possible for the sheep station to meet each dry year successfully. On the other hand, many sheep outfits in southeastern Idaho (the same general region in which the sheep station is located) had to leave the ranges earlier in the fall of 1926 than in the average year.

Studies of the early grazing problem now show that the range is deteriorating in grazing value where it has been fully grazed each year since 1923 from the time growth began in the spring until the sheep were taken to the summer range in mid-June. At present the results of the experiments indicate that it is not advisable to graze a given range each year for full use from the time that growth starts in the spring.

A certain portion of the sheep-station range was rather heavily grazed prior to 1923. Since that time this area has not been grazed at all in the spring but full use has been made of its forage each fall. This has resulted in a very decided improvement of the forage growth. The plants have had an opportunity to renew their vigor and produce a crop of seed each year.

One of the first steps in range management is to determine the amount of range necessary for a given number of

animals, or, stated otherwise, the stockman must determine the number of animals that the available range will carry for the proper season of use. This point in management is just as much a business proposition as is figuring the amount of hay necessary for the winter season, but it is a difficult matter because so many factors are involved. The carrying capacity varies with the amount of the vegetation there is on the ground, the palatability of the plants, the variation in growth from year to year, the way the sheep are handled, and numerous other factors. Such figures as are available indicate that the carrying capacity of the sheep-station range, under present conditions, is approximately 1 acre per ewe per month for 2½ months in the spring and 2½ months in the fall. In other words, the total period of 5 months for spring and fall grazing requires about an average of 5 acres per ewe. Summer and winter grazing and winter feeding must be furnished in addition to this. This is based on the plan of making due allowance for extremely dry years and provision for range improvement in the good years.

The special lamb-production experiments have now been in progress three full years, in which a band of 1,200 ewes has been kept. Half of these ewes are Rambouillets and the other half are Corriedales. Half of the Rambouillet ewes were bred to Rambouillet rams and the other half to Hampshire rams, while half of the Corriedale ewes were bred to Corriedale rams and the other half to Hampshire rams. All of the lambs sired by Hampshires and the Corriedale wether lambs that fatten on the range were sold and slaughtered in Chicago and at Beltsville under an experimental arrangement, and 200 of the feeder lambs were used in the feeding experiments at the Purdue University Experiment Station, La Fayette, Ind. Lambing percentages of the Corriedale ewes have been considerably greater than those of the Rambouillets, and Hampshire-sired lambs have weighed the most. These lambs are used extensively in the work of the project, "A study of factors which influence the quality and palatability of meat." Statistical analysis of these meat data has progressed considerably. During the year 580 correlation coefficients were completed and are being used in the discovery of important factors which influence the quality and palatability of lamb meat.

The investigations in range-sheep breeding are being continued with Rambouillet, Corriedale, and Columbia sheep. Progress is being made in the discovery of factors which influence the production of lambs and wool with these breeds under range conditions. As the facts resulting from this work become available they are put to the actual breeding test for the purpose of determining their usefulness in actual practice. A recent study of the data on these breeds showed that for a three-year period covering 1923, 1924, and 1925 the average weight of lambs at weaning time (at about 4½ months old) was 68.95 pounds for Rambouillets, 73.02 pounds for Corriedales, and 78.02 for Columbias. The fleece weights for the yearling ewes for this same period averaged 9.56 pounds for Rambouillets, 9.75 for Corriedales, and 10.98 for Columbias; and for the ewes of breeding age (2 years old or older) the fleeces averaged 10.82 pounds for Rambouillets, 8.28 for Corriedales, and 11.27 for Columbias. In 1926 the Rambouillet ewes produced, by weaning time, an average of 47.54 pounds of live lamb per ewe, the Corriedales 61.42 pounds, and the Columbias 57.08 pounds.

These variations in lamb production were due in large measure to differences in lambing percentage (number of lambs born per 100 ewes on hand at breeding time), which was 71.01 per cent for Rambouillets, 88.90 for Corriedales, and 76.60 for Columbias. In the summer of 1926 the sheared weights of the yearling ewes averaged 89.95 pounds for Rambouillets, 84.31 for Corriedales, and 96.40 for Columbias. It should be remembered that all these sheep are maintained under actual range conditions. About 4,500 sheep and lambs were used in the definite experiments at Dubois.

At Miles City the range sheep studies have covered range utilization, feeding and studies in wool and lamb production. The feeding experiments with breeding ewes showed that ewes fed grain on the range during the winter produced lambs that were slightly heavier at birth and at weaning time than the lambs from ewes receiving no grain on the range.

The chief advantage of this practice of feeding the ewes grain on the range during the winter as shown in this trial seems to lie in the quantity of hay saved in the winter feed lot. Lamb-fattening experiments were conducted with about 400 lambs. Rations of (1) screenings and alfalfa hay, (2) screenings, alfalfa hay, and corn silage, and (3) barley and alfalfa hay, were compared. The lambs receiving

silage with screenings and alfalfa hay made more rapid and cheaper gains, shrunk less in shipment to market, obtained a higher grade of finish and sold for a higher price than the lambs that were not fed silage but only screenings and alfalfa hay. Difficulty was encountered in getting the barley-fed lambs promptly on full feed and their consumption of barley was less than the consumption of screenings by the lambs receiving only screenings and alfalfa hay. About 2,600 sheep and lambs are on hand at the Miles City station.

The range-sheep studies in Texas are conducted in cooperation with the Texas Agricultural Experiment Station at its substation No. 14 in the locality of Sonora, Tex. The object of this investigation is to determine the relative adaptability of Rambouillet and Corriedale sheep to the conditions of southwestern Texas in the region of the Edwards Plateau. The factors under consideration are prolificacy; hardiness; maturity; growth, weight, length, fineness, and character of fleeces; shrinkage and selling value of wool; grazing qualities; susceptibility to disease and parasites; and mutton qualities.

A very large portion of the sheep of Texas are Rambouillets and the wisdom of avoiding any abrupt change there from a predominance of Rambouillet is fully recognized. About 300 sheep and lambs are maintained for this project, and of this number about 60 are Corriedales.

STUDIES IN WOOL AND OTHER ANIMAL FIBERS

A total of 680 coefficients of correlation were worked out in connection with a study of factors which influence wool production. The interpretation of these and allied data was prepared for use in a department bulletin on the subject. About 1,500 fleeces from sheep of known breeding were analyzed and studied for content of clean wool, grease, and dirt. Investigations with about 250 fleeces were conducted to determine the relationship between shrinkage and the volume occupied by known weights of different kinds of wool under definite pressure, in an attempt to work out a practical wool-shrinkage test. Results of methods of scouring raw wool were prepared for publication. A study was made of the occurrence of kemp in mohair in which fibers of good mohair and undesirable kemp were measured for length and diameter. This work was finished and prepared for publication in a department bulletin. Studies on the structure of horse, cattle, and hog hair were carried on in connection with committee work on Government-purchase specifications.

Field work on wool was conducted with sheep at the Federal stations near Dubois, Idaho; Miles City, Mont., Middlebury, Vt., and Beltsville, Md. Cooperative investigations on studies in the growth of wool were conducted with the State experiment stations of Ohio, Michigan, Minnesota, Montana, Wyoming, Idaho, Washington, and Oklahoma. Cooperative studies in the growth of mohair were started with the State experiment station of Texas.

GOAT INVESTIGATIONS

Experiments with milk goats were continued at Beltsville, Md. Toggenburg and Saanen goats were used in studies of the problems of breeding, feeding, and milk production. These results furnish much useful information that is in great demand by people in all parts of the country. The herd includes about 60 goats and kids. About 24 Angora goats are being used in the cooperative studies in the growth of mohair at College Station, Tex. These studies in mohair are designed for the discovery of much-needed information on methods to be pursued in the improvement of mohair.

HORSE AND MULE INVESTIGATIONS

The work in horse and mule investigations was carried on during the year in three major projects: (1) Breeding, feeding, and management of Morgan horses; (2) production and use of horses under range conditions; and (3) feeding and using city work horses.

BREEDING, FEEDING, AND MANAGEMENT OF MORGAN HORSES

A project to study the breeding, feeding, and management of Morgan and other light horses is carried on at the United States Morgan Horse Farm, Middlebury, Vt., where a stud of 52 horses was maintained. Purebred Morgan horses have been used as material for obtaining these data under New England conditions.

The size of the horses produced in the project has been increased constantly, the average increase being 1½ inches, and the average quality has been greatly improved. This is indicated by premiums won by horses bred on this farm whenever shown in open

competition. The stamina of these horses has been developed also, as they have made creditable performance in the 300-mile endurance contests which are held annually. The constant demand for breeding animals produced in this stud is an indication that the individuals and the blood lines represented in them are greatly desired for the improvement of horse stock in other sections of the country as well as in several foreign countries.

PRODUCTION AND USE OF HORSES UNDER RANGE CONDITIONS

At the United States Range Livestock Experiment Station, Miles City, Mont., complete data relating to the breeding, feeding, management, and use of draft and saddle horses under range conditions have been kept since the inception of the work. No specific results can be reported at this time, as the work has been under way only a short time, the first foal crop having been dropped during the spring of 1927. Approximately 150 horses, draft and saddle, are being used in this project.

FEEDING AND USING CITY WORK HORSES

Investigations on the feeding and use of city work horses were conducted during the year at Bridgeport and other points in the State, in cooperation with the Storrs Agricultural Experiment Station, Storrs, Conn. The object was to determine the most suitable quantities of legumes and grass hays for working and idle horses in combination with oats and other concentrates. Before this work started, the horses in this experiment were receiving from 25 to 30 pounds of hay a head daily. These experiments provide for the grouping of the horses on test in groups which are obtaining 8, 12, and 16 pounds of hay per head per day. The results thus far indicate that horses receiving the minimum quantity of hay in the group method of feeding are doing work as efficiently as those receiving the maximum quantity. It is almost conclusive from the results already attained that the horses were previously receiving more hay than necessary for efficient work, and that a great saving in roughages for city horses may be accomplished without affecting their efficiency.

CERTIFICATION OF PEDIGREES

During the year there were certified by this bureau under the provisions of paragraph 1506 of the tariff act of 1922, the following purebred animals imported for breeding purposes: Horses, 440; cattle, 2,561; sheep, 1,817; swine, 223; dogs, 2,224; cats, 15; total, 7,280.

POULTRY INVESTIGATIONS

Considerable progress was made in the adoption of uniform State rules and regulations in respect to the accreditation and certification of hatcheries and breeding stock. Included in this general plan of accreditation-certification is the standardization of official egg-laying contests of the country.

Much time was spent in preparing for the representation of the United States at the World's Poultry Congress, held in Ottawa July 27 to August 4, 1927.

The investigational work under way at the experiment farm, Beltsville, Md., was continued and plans were made for new projects.

POULTRY BREEDING

Regular breeding work for increased egg production in Rhode Island Reds and Single-Comb White Leghorns was continued, average egg production for the last year being higher than for any year previously. In White Leghorns two high records were established—one of 300 eggs and another of 312.

In developing the laying strains, particular attention is given to size and shape of egg, as well as hatchability, from the females that are used as breeders.

The results obtained in respect to hatchability of eggs and livability of chicks—the latter meaning the number of chicks alive at 4 weeks of age—have improved steadily during the last three years.

In 1927, among the Rhode Island Red chicks, there was only 1.25 per cent mortality up to 4 weeks of age, and in the Single-Comb White Leghorns only 3.17 per cent mortality up to 4 weeks of age.

Inbreeding work with Barred Plymouth Rocks and White Leghorns was continued and the results shown were of interest, particularly from the standpoint of decrease in hatchability as inbreeding continued. In several instances hatchability declined to less than 50 per cent.

The biological study of hen-feathering in descendants of an original cross between Golden Spangled Hamburgs and Brown Leghorns was continued in two matings.

Study was continued of the inheritance of comb and crest characters in descendants of an original Silkie-White Leghorn hybrid mated to White Plymouth Rock females. In this particular mating the inheritance of other characters is also being studied.

Several varieties of Plymouth Rocks are being used in a study of the inheritance of color pattern. The same pens, in conjunction with two pens of Single-Comb White Leghorns, are the basis of a study in the inheritance of egg shape. This character in Plymouth Rocks and the Single-Comb White Leghorns differs materially.

POULTRY FEEDING

Feeding experiments with laying hens were continued in a study of the effects on egg production of various amounts of protein in meat scraps and dried skim milk. Twelve pens of 25 Leghorn pullets each were in the tests. Previous results were verified and new tests conducted on higher protein levels, ranging up to 25 per cent of both meat and milk. Reduced egg production and body weight have resulted consistently with meat rations below 14 per cent protein levels, and on milk rations below the 12 per cent levels. Egg production increased materially on both the meat and the milk feeds until the milk rations reached about 17.5 per cent protein levels, and the meat rations reached 20 per cent protein levels. Protein levels above 20 per cent on the meat rations have given a moderate increase in egg production, the increase continuing, but at a steadily decreasing rate, up to 25 per cent protein levels. The tests on the higher protein levels with skim-milk powder have not given increased egg production above the 20 per cent protein level, and the use of over 40 per cent of skim-milk powder in the ration gave an excessively laxative reaction which appeared to affect the hens adversely. Milk proteins between the 12 per cent and the 17.5 per cent levels gave better egg production than the meat proteins. These rations were made of either meat or milk and corn meal supplemented with minerals and 2 per cent alfalfa meal.

Five separate tests, each containing about 14 pens of 50 chicks each, were carried out on similar protein experiments with White Leghorn chickens. A sixth test is now in progress. Each test continues for 14 weeks.

With both the dried skim milk and the meat meal rations, protein levels of 17.5 per cent have given the best growth and the lowest mortality. With protein levels between 10 per cent and 17.5 per cent, the milk powder has given somewhat better growth than the meat meal. Protein levels between 20 per cent and 25 per cent in either meat or milk have not given increased growth over the rations containing from 17.5 per cent to 20 per cent protein. The growth obtained from these higher protein levels has varied greatly, and the results have apparently been materially affected by the calcium-phosphorus ratio of the ration.

Different mineral mixtures used as supplements to the rations in some of the tests have affected growth as much as moderate changes in the protein levels.

Leg weakness in some instances has also affected the results, although 2 per cent of cod-liver oil was included in all tests.

These variations have made a more thorough study of the mineral supplements necessary.

Radiation with ultraviolet rays for 20 minutes daily did not increase egg production with 10 White Leghorn pullets which had the use of small outside yards. The effect of this treatment on the weight of the eggs and of the egg shells is still being studied. The use of the ultraviolet rays on growing chicks, which also had a small outside yard, did not increase growth or otherwise benefit the chickens.

An experiment was conducted to determine the influence of specific substances on the molting of chickens. The purpose of the experiment was to find some means of advantageously affecting the molt from the point of view of annual egg production. The method was to supply certain substances, such as silica and sulphur, which are normal constituents of feathers (sulphur also being an important normal constituent of eggs), and in which the rations fed to laying hens are frequently deficient. Four pens of 15 birds each were used, the birds being distributed among the four pens on the basis of their egg production up to June 1, 1926. The experiment began June 10, 1926. All pens received the same basal ration containing the same total amount of mineral matter. The rations differed only as follows:

The mineral matter of pen 1 contained sodium silicate; that of pen 2 contained a mixture of sulphur compounds; that of pen 3 (the control pen) contained neither the silicate nor the sulphur compounds, while pen 4 contained both the silicate and the

sulphur compounds. Beginning June 17, 1926, weekly measurements were made of the length of growing feathers on the side of the tail, in the wing, and on the side of the breast. Observations were made at the same time on the stage of the molt. The making of these measurements was continued until January 6, 1927, by which time very nearly all the feathers under observation had completed their growth. The results indicate that the final length of the individual feathers and the time required for their growth were not affected. The time of the molt was apparently affected, inasmuch as most of the birds in the pen receiving the mixture of sulphur compounds began molting approximately six weeks later than the other three pens. Egg production in all four pens practically ceased by November 1, 1926, and did not begin again until January, 1927. During the period between June 10 and January 1 (205 days) the average egg production of each pen, per bird and per day, was as follows: Pen 1, 0.173; pen 2, 0.249; pen 3, 0.147; pen 4, 0.102.

Another experiment was conducted to determine the maintenance requirements of chickens. The "increment" method was used. This method consists in feeding a number of pens at different nutrient levels which differ from each other by a fixed increment. The individual birds are weighed at the beginning and end of each experiment and the gain or loss in live weight for each lot determined. If there is any egg production, records of it are kept. By means of suitable mathematical analysis the maintenance and egg production (if eggs were produced) requirements may be calculated. Four such maintenance experiments were conducted, two with pullets and two with cockerels. Those with pullets were very satisfactory but those with cockerels were not, because of fighting and excessive activity of the birds. The first lot of pullets produced some eggs whereas the second lot produced practically none. Data from the first lot indicated that 77 grams of the particular feed mixture used were required, in addition to the maintenance requirement, to produce an egg.

A report entitled "Vitamin A in Poultry Flesh and Fat" was published in the Journal of Agricultural Research, and an article on the Vitamin Requirements of Laying Hens has been submitted for publication in that journal. The work on vitamins was conducted in cooperation with the Biochemic Division.

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BIOCHEMIC DIVISION

The work of the Biochemic Division, under M. Dorset, chief, consisted, for the most part, of chemical and bacteriological researches on problems concerning dips and disinfectants, hog cholera, tuberculin and mallein, and meats and meat food products.

INVESTIGATIONS OF DIPS AND DISINFECTANTS

Routine laboratory analyses were made of 156 samples of disinfectants, dips, viruses, serums, etc., particular attention being given during the year to the examination of viruses and serums for the purpose of testing the accuracy of the new field-test method for phenols as applied in establishments holding licenses for the preparation of viruses, serums, toxins, and analogous products.

FIELD TESTS FOR DIPPING BATHS

During the year there were prepared and forwarded to inspectors in the field for testing the strength of dipping baths, 414 new test outfits for arsenical dips, and supplies sufficient to make 272,600 field tests; 31 new test outfits for lime-sulphur dips, and supplies sufficient to make 7,400 tests; and 2 new outfits for testing nicotine dips, and supplies sufficient to make 4,320 tests.

For the field estimation of phenol in stock solutions and anti-hog-cholera serum and virus, one new outfit and supplies sufficient for 3,500 tests were forwarded to field inspectors.

MODE OF ACTION OF DISINFECTANTS

The work with the higher phenols, with the resorcinols and cyclohexanols, and various branched chain alcohols was completed and a report of the work is now in press. These investigations have shown that definite ratios exist between the bactericidal efficiencies of successive members of the different series of compounds studied. This indicates that the bactericidal powers of any two members of a series are affected essentially to the same degree by the introduction of a methyl group. These findings have enabled the accurate prediction of bactericidal efficiency of a number of compounds to be made in advance of their preparation. It has been

found also that certain classes of compounds exhibit more or less specific toxicity for certain bacteria, while comparatively ineffective against other species. One of the compounds prepared has shown against *Staphylococcus aureus* the extremely high coefficient of 1,000. The high-coefficient disinfectants, however, have been found to be interfered with by organic matter to a far greater extent than some of the disinfectants of a much lower coefficient. For example, the one compound which was capable of killing *S. aureus* in the proportion of 1 to 75,000 was so affected by the presence of 50 per cent of blood serum that a dilution of 1 to 1,000 was required under those conditions to kill the same microorganism. Efforts have been made to determine the therapeutic power of some of the other high-coefficient compounds which have been produced. In all cases thus far studied the disinfectants employed have proved to be entirely without therapeutic value when administered to laboratory animals affected with certain forms of septicemia.

STUDIES OF SAPONIFIED PHENOL SOLUTIONS

Studies were directed during the year toward determining the cause of the irritation brought about by saponified phenol solutions when applied to animal tissues. Attention has been paid to the action of excess alkali, excess oil, nature of the soap, nature of the phenol, and proportion of soap to phenol. The most interesting part of these observations has been to show that within certain limits (4 per cent) neither excess alkali nor unsaponified oil seems to increase the irritating action of the neutral soap solution of phenols. The kind of soap apparently makes no difference, but the nature of the phenols seems to be of much importance, the irritating effect increasing with the complexity of the phenols in a given series.

MECHANISM OF THE ACTION OF SOAPS

Certain soaps by themselves appear highly effective against certain bacteria and insects. Also soap is an important constituent of some germicides and insecticides. As a prerequisite to understanding the function of soaps in such applications it has seemed necessary first to obtain a better understanding of the action of soaps upon inert, nonliving matter. Consequently studies were made upon the relative powers of various soaps to disperse oil into a fine emulsion and to break up carbon black into a finely divided, colloidal, or deflocculated condition. The work thus far has resulted in the publication of several papers in technical journals, but the results have not yet been comprehensive enough to warrant definite recommendations for the best utilization of soap in practice.

TUBERCULIN AND MALLEIN

The production and distribution of tuberculin and mallein for official use by bureau and State inspectors was continued. During the year the total quantity of mallein supplied was 19,120 doses, constituting approximately 4,000 more doses than were supplied during the preceding year. The year's output of tuberculin was as follows: Subcutaneous tuberculin, 599,790 cubic centimeters; intradermic tuberculin, 2,110,585 cubic centimeters; ophthalmic tuberculin disks, 3,607,170. The total production of tuberculin during the year amounted to approximately 14,310,042 doses.

As a result of the chemical researches on tuberculin, which have been in progress for some time, it was found during the year that certain inorganic substances such as charcoal, fuller's earth, and powdered kieselguhr, were capable of adsorbing the active principles from solutions of tuberculin. Of these three adsorbents, charcoal proved to be the most active.

A study of the effect of dialysis on the active principles of tuberculin showed that in certain cases it was possible to separate, although rather imperfectly, two biologically active principles from tuberculin. The fraction which did not pass through the dialyzers and therefore was of large molecular size contained practically all of that portion of the tuberculin which causes skin reactions in guinea pigs. The portion which passed through the dialyzers was, on the other hand, practically devoid of power to produce skin reactions, yet possessed a very considerable part of that portion of the tuberculin which is capable of bringing about the death of tuberculous guinea pigs when injected intraperitoneally. Practically the same effect as was obtained by dialysis was secured by means of ammonium sulphate. When certain tuberculin solutions were saturated with ammonium sulphate it was found that all of the skin-reacting material was precipitated, while a large part of the lethal principle remained in solution and passed through filters.

These results were found to hold good with all tuberculins prepared from old cultures which had become decidedly acid in reaction. Later studies showed that if tuberculins were prepared from cultures before they had undergone the change from an alkaline to an acid reaction, this separation could not be effected. In the younger alkaline cultures the lethal material appears to be associated in some way with other material, perhaps the skin-reacting material, so as to form a molecule of large size which is precipitated by ammonium sulphate and which is withheld by the dialyzers. These observations may prove to be of much importance because they indicate that the power of a tuberculin to kill tuberculous guinea pigs is not necessarily a guide to its power to produce skin reactions. Since the lethal power of tuberculin has in the past been used quite generally to measure the potency of the product, the importance of these observations will be apparent. This work is being continued in the hope that the research will lead to better methods of producing tuberculin, to a more uniform product, and to improved methods of standardization.

HOG-CHOLERA INVESTIGATIONS

During the year there were prepared at the experiment farm at Ames, Iowa, 87,000 cubic centimeters of serum and 57,343 cubic centimeters of virus. This serum and virus were used largely in connection with the immunization of young pigs at the seven farms which are controlled by the Animal Husbandry Division. The spring and fall litters of pigs at these farms were immunized by the simultaneous method with satisfactory results.

During the year 19 commercial products were tested for purity and potency, as follows: 9 samples of commerically produced anti-hog-cholera serum, 2 samples of hog-cholera virus, and 8 samples of hemorrhagic-septicemia aggressin.

Six of the samples of serum were near, or had passed the prescribed time limit for commercial use. The object of these serum tests was to gather information concerning the effect of age on the potency of anti-hog-cholera serum. At the same time there were tested a 9-year-old clear serum of the division's manufacture, and a defibrinated blood serum 6 years old. The system used for testing was the same as that for the testing of commercial serums in licensed establishments. All the serum tested proved to be of satisfactory potency. The samples of commercial virus were likewise found to fulfill the requirements of the bureau and the samples of hemorrhagic-septicemia aggressin were found to be sterile and without toxic action upon healthy animals. The efficacy of these aggressins for preventing hemorrhagic septicemia was not determined.

EXPERIMENTS WITH FORMALINIZED BLOOD AND FORMALINIZED SPLEEN

Experiments with formalinized hog-cholera-virus blood, previously reported, were continued. Four lots of formalinized virus were prepared and kept for different lengths of time, ranging from 14 to 53 days, before being used for the injection of pigs. In some cases the virus was injected alone and in other cases in combination with an equal amount of anti-hog-cholera serum. None of the pigs treated with formalinized blood became sick thereafter, but most of them succumbed when later exposed to hog cholera. It seems that formalinized hog-cholera blood can not be depended on as a means of producing immunity against hog cholera.

Since certain authorities had claimed that the spleen of animals affected with filtrable virus diseases, particularly fowl pest, after being emulsified and treated with formaldehyde (0.2 per cent) was capable of producing a firm immunity in animals, the same procedure was tried as a means of protecting hogs against cholera.

In the first test of the spleen emulsions the pigs injected with the emulsions remained well until infected with hog-cholera virus 19 days later. They then contracted the disease, thus showing that they had not been immunized by the spleen emulsions. In the second test the formalinized spleen emulsions, after being held 38 days in storage, were injected in doses three times as large as the first dose employed. In this case the spleen emulsion produced hog cholera in all of the injected pigs, although the period of incubation was much prolonged.

A second experiment with a different lot of formalinized-spleen emulsion prepared the same as in the first work was used for the injection of pigs for purposes of immunization. No ill effects followed this injection.

TEST OF SULPHURIC ACID AS A PREVENTIVE AND CURE FOR HOG CHOLERA

To determine the preventive power of sulphuric acid, two susceptible pigs

were given sulphuric acid regularly in their drinking water twice a day, in the proportion of 1 tablespoonful to a gallon of water, for a period of 16 days. These pigs were then placed in a pen with pigs affected with cholera, and the sulphuric acid was continued in the drinking water as before. Both of the pigs which had been treated with sulphuric acid contracted the disease in the usual time. To test the effect of sulphuric acid as a cure for hog cholera, four pigs were infected by virus injection and just as they were beginning to get sick they were given sulphuric acid in the drinking water, twice daily, 1 tablespoonful to to the gallon. All the experimental pigs continued to sicken and develop typical symptoms of hog cholera. The sulphuric-acid treatment appeared to be of no value whatever, either as a preventive or a cure.

TESTS OF LUGOL'S SOLUTION OF IODINE AS A CURE FOR HOG CHOLERA

Five pigs were treated by subcutaneous injection, some being given a single injection, others two injections, in the early stages of the disease. The dose of iodine administered was 0.5 gram. This treatment was without effect on the course of the disease. Four other pigs, three of which were in the early stages of the disease, were given an intravenous injection of Lugol's solution, the dose of iodine being approximately 0.025 gram. The intravenous injection likewise had no effect upon the disease. It therefore appears that Lugol's solution is of no value in the treatment of hog cholera.

TEST OF SOWS FOR NATURAL IMMUNITY

Three crossbred sows weighing approximately 100 pounds each were received from August A. Busch, of St. Louis, Mo. These animals were a cross of the wild hog of Germany with native American hogs, and they resembled somewhat the German wild boar in appearance. They were said to be naturally immune against hog cholera. These pigs when received were in good condition, and were held in quarantine for three days. Being at that time perfectly well they were placed in a pen with two native pigs, which had previously been injected with the virus of hog cholera. At the same time two untreated susceptible pigs were placed in the same pen. The two native pigs injected with hog-cholera virus developed typical hog cholera. The three crossbred sows and two native susceptible controls all contracted hog cholera by exposure, and all showed first visible symptoms of the disease one week after appearance of symptoms in the infected animals. All five exposed hogs developed typical cholera and showed characteristic lesions at autopsy. There was no evidence of immunity in the crossbred sows.

ADSORPTION OF HOG-CHOLERA VIRUS BY CALCIUM CARBONATE AND KIESELGUHR

Two experiments were carried out with two different lots of virus. In both experiments the serum obtained from the virus blood was diluted, in one case with 10 parts of physiological salt solution, and in the other with 100 parts, before being mixed in the proportion of 1 gram to 10 cubic centimeters. After removal of the kieselguhr and calcium carbonate, the clear virus solutions were tested for potency. There seemed to be only slight adsorption of the virus by calcium carbonate, while the kieselguhr was much more active, as shown by the prolonged incubation period. In no case was the virus completely adsorbed.

EFFECT OF SODIUM RICINOLEATE ON HOG-CHOLERA VIRUS

Sodium ricinoleate has been reported to be an active detoxifying agent for bacterial toxins. In order to determine the effect of this soap on hog-cholera virus, a 1 per cent solution of pure sodium ricinoleate was prepared and mixed in equal proportion with a solution of the laked red blood cells obtained from a pig sick of hog cholera. The mixture remained clear. After contact of three and one-half hours pigs were injected with the treated laked cells. These animals developed hog cholera in typical form and within a very short time. There was no evidence of attenuation of the virus by the ricinoleate.

EFFECT OF B. SUIPESTIFER ON IMMUNIZATION OF PIGS AGAINST CHOLERA

In these experiments the object was to determine whether the presence of *B. suipestifer* in the infecting virus would cause pigs previously immunized with virus not containing *B. suipestifer* to contract cholera and also at the same time to determine whether immunization with virus containing suipestifier would prevent such breaks in immunity. For the purposes of this

study 24 pigs were immunized by the simultaneous method, using virus containing *B. suipestifer*, and 25 pigs were immunized at the same time with virus free from *B. suipestifer*. The 49 pigs thus immunized were held on pasture for from two to four months and then subjected to an immunity test by the injection of virus containing *B. suipestifer*. The results of this test of immunity were that both groups of pigs remained well after injection with hog-cholera virus containing *B. suipestifer*, while nonimmune controls promptly contracted the disease.

In connection with these experiments further studies have been made of the survival of *B. suipestifer* in virus after the addition of 0.5 per cent phenol to the defibrinated virus blood. After the addition of the phenol to the viruses the mixtures were held in a refrigerator at a temperature varying from 45° to 50° F. Daily bacteriological counts were made. The results obtained agree with those previously reported. That is, *B. suipestifer* in the virus was found to have lost its viability after 10 days. While these experiments are not conclusive with respect to the part played by *B. suipestifer* in so-called hog cholera "breaks" in immunity, it is evident that they afforded no indication that that microorganism is an important factor in such cases.

INVESTIGATIONS OF MEAT AND MEAT FOOD PRODUCTS

As a result of experiments completed during the year, the liver was found to be the most important source of vitamin A among the edible viscera of cattle, sheep, and hogs. The kidneys and heart seemed to follow next in order, while the brain, spleen, and lungs seemed to contain smaller amounts.

The study of the composition and nutritive value of sausage and similar products was continued. A chemical examination of 205 of these samples, including 17 grades and classes of fresh and smoked sausage, was completed. The average protein content of the samples ranged from 8.01 per cent in scrapple to 16.53 per cent in smoked, country-style sausage; the average fat content varied from 12.34 per cent in souse to 44.83 per cent in pure pork sausage, and the average fuel value per pound varied from 766 calories in the case of souse to 2,094 calories for pure pork sausage.

The studies of the biological value of the proteins of the different classes of sausage are still in progress. A preliminary study of the effect of cooking upon the nutritive value of the proteins in beef was made by feeding tests with albino rats. So far as these comparative studies have gone, they have indicated no appreciable difference in the nutritive value of the protein in cooked as compared with that in the raw meat.

INSECTICIDE AND FUNGICIDE WORK

The work, in cooperation with the insecticide and fungicide board, on products intended for use in the treatment of domestic animals was continued. As a result of the recent discontinuance of the insecticide and fungicide board of the department and the concentration of the work of the board in the new Food, Drug, and Insecticide Administration, the laboratory work on insecticides and fungicides previously carried out by the Bureau of Animal Industry was taken over on July 1, 1927, by the new administrative unit.

EXPERIMENT STATION

The work of the experiment station at Bethesda, Md., under E. C. Schroeder, superintendent, was similar in its general character to that of previous years. It consisted of independent investigations of the infectious diseases of domestic animals, studies on the possible occurrence of disease germs in food products derived from animals, tests of alleged remedies for and immunizing agents against infectious diseases, investigations in cooperation with other scientific divisions, and the furnishing of materials and facilities for other divisions to conduct investigations under natural or normal farm conditions.

BOVINE INFECTIOUS ABORTION

The sanitary control methods, based on the known etiology of bovine infectious abortion, where the facilities are sufficient for their careful application, have proved effective in the various tests that have been made. They do not seem, however, to be economically applicable in all infected herds. The insidious character of the disease, the frequency with which its subjects serve as apparently healthy carriers and periodic disseminators of its prime causative agent, and uncertainty about the time that may elapse between the moment an animal becomes infected and when it begins to react with biological tests make it desirable that some method of im-

munization be developed. Such a method would find a valuable use where sanitary measures alone can not be practiced with the consistency and thoroughness on which their success depends. Hence experiments have been continued to determine how much immunity against abortion may be engendered by using swine strains of abortion germs, which have a low degree of infectivity for cattle, to immunize cattle, and cattle strains, which have a low degree of infectivity for swine, to immunize swine. The experiments, as far as they have gone, are encouraging, but results are still inconclusive.

Additional studies are also in progress on the mode of dissemination of abortion germs and on the portals through which they may enter the body. The increasing frequency with which instances of human infection with the bacillus of bovine infectious abortion are being reported seems to justify the conclusion that high grades of milk intended for consumption in the raw state should be obtained from cows proved free from abortion infection. This in particular applies to the production of so-called certified milk.

TUBERCULOSIS

The method of immunizing against tuberculosis known as the Calmette, or B. C. G. method, remained a subject of study during the year. The first tests indicated that vaccination with B. C. G. increased resistance against tuberculosis although it did not provide anything approaching complete immunity, and later tests were even less encouraging. The B. C. G. vaccine is a living, attenuated culture of an originally virulent bovine tubercle bacillus, and it should be kept in mind that our present knowledge of the fate of living tubercle bacilli in the bodies of animals requires that we should be very careful about adopting any alleged method of tuberculosis control which requires exposure to living tubercle bacilli of any kind, type, or degree of virulence.

Even if the B. C. G. vaccine eventually is proved to give a sufficient degree of immunity against tuberculosis to justify its use in the control of bovine tuberculosis in Europe, it would not follow that its use would be justified in our country. The relatively small percentage of tuberculosis among our cattle, the available and growing sources from which slaughtered, tuberculous cattle can be replaced, make bovine-tuberculosis eradication with us a simpler and less difficult problem than it is in Europe, where the number of cattle in proportion to the population is much smaller and tuberculosis among cattle is from 10 to 15 times greater.

A number of investigations on tuberculosis which do not at present offer suitable material for a brief report are being conducted. It is being determined how long ingested tubercle bacilli may remain in the digestive tracts of cattle and in what way this period of time may be related to that degree of infection on which sensitiveness for tuberculin depends; the permeability of the mucous membranes of cattle of different ages for tubercle bacilli is being studied; and investigations are being made on the possible multiplication of tubercle bacilli in the digestive tract.

One subject in this connection merits attention; that is so-called skin lesions which have a tuberculous character, which contain acid-fast bacilli microscopically indistinguishable from tubercle germs, and which often occur in tuberculin-reacting cattle that show no other evidence of tuberculosis. The samples of such lesions, sent to and studied at the experiment station, in all instances proved to be subcutaneous and not cutaneous or true skin lesions. The acid-fast germs they contained in all instances failed to grow on culture media on which tubercle bacilli grow, and the inoculation of such lesions into experimental animals highly susceptible for tubercle bacilli failed to cause tuberculosis or other disease. Efforts are being continued to learn more about their nature.

The purity and potency of commercial tuberculins have been currently tested, and it is hoped that recent discoveries may reduce the cost and complexity of such tests without reducing the reliability of the results obtained.

VESICULAR STOMATITIS

In addition to the harm it does, vesicular stomatitis derives special importance from the close resemblance of its lesions to those of foot-and-mouth disease and consequently has remained a subject of study. As in the case of foot-and-mouth disease, there seem to be different strains of its virus, recognizable only through the immunity each engenders against itself but not against other strains.

MISCELLANEOUS

Numerous minor investigations were made; dairy products were tested

relative to their contamination with tubercle bacilli; a large number of small experiment animals were raised; and all portions of the station not needed for other purposes were kept under intense cultivation to provide fresh vegetable feed for experimental animals.

FIELD INSPECTION DIVISION

The Field Inspection Division, under A. W. Miller, chief, conducted the field work in connection with precautionary measures against foot-and-mouth disease and European fowl pest. It also continued its regular activities for the control and eradication of certain diseases of livestock, the enforcement of livestock quarantine and transportation laws, and the administration of regulations governing the importation and exportation of livestock and those providing for the sanitary handling of hides, skins, wool, other animal by-products, hay, straw, forage, fertilizers, bagging material, etc., offered for importation into the United States.

COUNTRY FREE FROM FOOT-AND-MOUTH DISEASE

There has been no outbreak of foot-and-mouth disease in the United States since October 15, 1925, when the last known diseased herd in the Texas outbreak of that year was destroyed. As a precautionary measure, however, several experienced veterinarians were continued on patrol duty during the summer and fall months of the present fiscal year in the areas in Texas and California in which infection had previously been found, but as there was no recurrence of the disease this force was entirely disbanded and its members returned to their regular lines of work on December 1, 1926.

INVESTIGATIONS OF EUROPEAN FOWL PEST

On a number of occasions bureau employees were detailed to investigate suspected outbreaks of European fowl pest, but in each case the report was negative. Infectious bronchitis caused heavy losses in a number of shipments of poultry to eastern terminal markets. Cars containing these infected consignments and those regularly used in the transportation of poultry were cleaned and disinfected under bureau supervision, 14,378 being so treated.

ERADICATION OF SCABIES

Inspectors in the field engaged in the work of eradicating sheep scabies, which was continued in cooperation with State officials, made 23,285,546 inspections and supervised 2,756,512 dippings of sheep. The number of sheep found to be infected on inspection was 530,842, which is approximately 45 per cent less than in the preceding year. Increased infection was reported only in Colorado, Nebraska, and Utah. Reports from Arizona, California, New Mexico, Texas, Wyoming, Kansas, Michigan, and Washington indicated a considerable reduction in the number of diseased sheep. Idaho, Montana, and Nevada again remained free and no infection was found in Oregon. In southern Mississippi, where investigation showed that sheep scabies existed rather extensively, 12 counties and a part of another were placed under Federal quarantine, and in Louisiana the quarantine was extended to include Calcasieu Parish. At the request of the State authorities regular eradication work was taken up in these two States and also in Kentucky and Virginia, where there had been a spread of the disease.

Bureau employees in the course of cattle-scabies-eradication work in cooperation with State officials made 3,132,939 inspections and supervised 722,565 dippings in the field. On inspection 136,448 cattle were found to be infected. When compared with the figures for the preceding year, this shows a slight decrease in inspections and a considerable reduction in infected animals and dippings. In Utah, which had been free from infection for several years, a small outbreak occurred involving cattle on nine premises. The disease was somewhat more prevalent in Oklahoma, Texas, and Washington, but reports showed considerable improvement in Colorado, Montana, Nebraska, New Mexico, South Dakota, Kansas, and Wyoming. No infection was found in Arizona, California, or Nevada.

ERADICATION OF DOURINE

The campaign for the eradication of dourine was continued in cooperation with State livestock sanitary officials and the Office of Indian Affairs. In Montana, where a small center of infection was found the preceding year, follow-up testing disclosed only a few more cases of the disease. For a number of years, due largely to the fact that the funds provided for the use of

the Office of Indian Affairs were not sufficient to permit an effective conduct of its share of the work, practically no progress was made on the Navajo Indian Reservation in Arizona, where dourine has existed rather extensively among Indian horses. However, that office was given an adequate appropriation for the present fiscal year and the work was prosecuted vigorously. Almost three times as many horses were tested as in the preceding year, and about twice as many reactors were found. In addition marked improvement in the situation was effected through the castration of about 5,000 surplus stallions, which if not thus eliminated, would have remained on the range, and in some instances at least been the source of further infection. One or two more seasons' work along the lines followed this year should witness the practical eradication of the disease from this reservation. The number of animals tested and the results of the tests are recorded on page 32.

LIVESTOCK SANITARY WORK IN INTERSTATE COMMERCE

Bureau employees at public stockyards, supervising the interstate transportation of livestock to prevent the spread of animal diseases, inspected 21,155,258 cattle, 20,925,004 sheep, and 37,362,112 swine. This was a reduction in the number of cattle inspected, but an increase in the inspections of sheep and swine. Of these animals 17,597 cattle and 877,361 sheep were dipped under bureau supervision to comply with regulations of the department or of States of destination, and 717,176 swine were immunized against hog cholera and disinfected for shipment to country points for feeding, breeding, and stocking purposes. The number of cattle and sheep dipped was somewhat greater than for the preceding year, and there was an increase of more than 68 per cent in the number of swine immunized. This large increase in immunized swine was due to the demand from livestock growers in the Corn-Belt States for feeder and stocker hogs to take the place of the animals that they had lost as a result of the extensive outbreaks of hog cholera, which occurred during the fall of 1926, and which in many instances practically wiped out their herds.

With a view to preventing the spread of hemorrhagic septicemia and reducing losses from that disease, arrangements were again made with transportation and stockyards companies for the cleaning and disinfection, under bureau supervision, of railroad stockyards regularly used in the feeding, watering, and resting of livestock and also of sections of public stockyards in which feeder and stocker cattle are handled.

On request of transportation companies and shippers or to comply with laws of States to which shipments were destined, bureau veterinarians inspected 21,827 horses and mules, of which 9,494 were tested with mallein, 1 animal reacting to the test. This was an increase of 4,131 inspections and 381 tests over the preceding year.

During the year, 34,729 cars carrying animals affected with communicable diseases were received at bureau stations. There were 79,752 cars cleaned and disinfected under bureau supervision, in compliance with department regulations or on request of Canadian Government officials, State officials, or transportation companies.

As has been the practice for a number of years, all ruminants and swine received at public stockyards were carefully inspected for foot-and-mouth disease by experienced veterinary inspectors especially assigned to that work, in order that there might be no delay in initiating control and eradication measures should an outbreak occur.

ENFORCEMENT OF TRANSPORTATION AND QUARANTINE LAWS

As a result of the continued enforcement of the law which prohibits the confinement of animals in cars longer than 28 hours without feed, water, and rest, further improvements were made in the facilities at stockyards regularly used in the handling of livestock in transit. In several instances old and inadequate yards were replaced by new ones properly equipped. During the year there were reported to the solicitor of the department for presentation to the Attorney General for prosecution 313 cases of apparent violations of this law. The penalties imposed in the cases decided in favor of the Government amounted to $50,950. Special investigation by bureau employees, such as interviewing witnesses and examining railroad and other records was necessary in many of these cases for the completion of evidence. Although four bureau employees were regularly assigned to this work, the gathering of evidence and the preparation of reports was done largely by inspectors at stockyard centers in connection with their other duties. There were also submitted to the Department

of Justice 52 cases of alleged violations of the quarantine laws and regulations. The fines imposed in cases decided in favor of the Government amounted to $5,640.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS

During the year revised regulations governing the importation of domestic livestock and other animals into the United States were promulgated. While these effected certain changes designed to facilitate the certification of animals prior to their shipment from foreign countries they were drafted with a view to the continued safeguarding of our domestic livestock from diseases of foreign origin. Every possible effort was made to accomplish the careful inspection of import animals and the three stations on the Atlantic coast provided for this purpose have been maintained in a condition to assure the quarantine of livestock in an efficient manner. This inspection service was successful, throughout the year, in excluding from the United States foot-and-mouth disease and other serious animal plagues.

Owing to the existence of foot-and-mouth disease and other serious diseases of livestock in most foreign countries importations of cattle, other domestic ruminants, and swine were limited to those from Canada, Mexico, Australia, New Zealand, the Channel Islands, Norway, and the Union of South Africa. The volume of imports of this kind was accordingly small. After fighting repeated outbreaks of foot-and-mouth disease in England for several years the British authorities were apparently successful in getting rid of the infection in April, 1927, and in June the issuance of permits for the importation of livestock from Great Britain was resumed. Up to the close of the fiscal year, however, no animals for which such permits were issued had arrived at United States ports. The number and kinds of animals imported are shown in Tables 1 and 2.

TABLE 1.—*Imported animals inspected but not quarantined*

Port of entry	Cattle	Swine	Sheep	Goats	Horses and mules	Asses	Other animals
Boston					31	1	
Galveston							2
Houston							6
Key West					563		
Los Angeles					34		27
New York					791		148
San Francisco					6		12
San Juan, Porto Rico	2,006	17		1	82	31	9
Tampa					38		
Canadian border ports	169,665	219,566	25,700	53	6,654	5	242
Mexican border ports	184,447	316	26,111	20	5,141	2	72
Total	356,118	219,899	51,811	74	[1] 13,340	39	518

[1] Of this number 2,704 were mules.

NOTE.—Mexican animals passed through United States territory under bond for return to Mexico and inspected at the time of entry were as follows: Cattle, 11,342; swine, 566; horses, 32; mules, 1.

TABLE 2.—*Imported animals inspected and quarantined*

Port of entry	Cattle	Swine	Sheep	Goats	Horses and mules	Asses	Other animals
Baltimore							6
Boston							102
Los Angeles							6
New York	800			8		14	149
San Francisco			16			2	2
Canadian border ports	931	59	7		4		
Mexican border ports							
Total	1,731	59	23	8	4	16	265

Under regulations of the Bureau of Biological Survey, 68,108 quail imported from Mexico were inspected and quarantined by inspectors of this bureau at time of entry.

Tuberculin tests were applied to 566 Jersey and 234 Guernsey cattle from the Channel Islands prior to their release from quarantine, without reactions to the test. Cattle from Canada for dairy or breeding purposes not accompanied by a satisfactory tuberculin test certificate were also tuberculin tested at time of entry. Of 842 Canadian cattle tested, 52 reacted to the test and were refused entry.

IMPORTATIONS OF ANIMAL BY-PRODUCTS, FEEDING MATERIALS, ETC.

Inspectors at ports of entry have continued to maintain a close supervision over animal by-products and various other materials offered for importation from countries in which foot-and-mouth disease exists. In the administration of the regulations an effort has been made to afford adequate protection and at the same time place the least possible hindrance upon importations of this kind. It seemed necessary during the year to make some provision for the control of scrap bagging entering the United States from countries infected with foot-and-mouth disease. This was done through a requirement that bagging of this character be either shipped in sealed cars direct to a paper mill for disinfection in process of manufacture or that it be subjected to disinfection by heat before leaving the port of entry. During the year a careful survey was made of tanneries, wool and glue factories, paper mills, and other establishments desiring to receive restricted products, the purpose being to eliminate any not equipped for the proper handling of materials of this kind.

Continued careful supervision has been maintained over hay and straw packing materials originating in countries in which foot-and-mouth disease exists and when not shown to have been properly disinfected prior to shipment, such hay or straw has been destroyed in order to avoid possible contact with domestic livestock.

INSPECTIONS OF ANIMALS FOR EXPORT

Care has been taken to make inspections and to issue certificates in the case of export livestock which would render the animals eligible for entry into various foreign countries. Especial attention has been given to the tuberculin testing of dairy and breeding cattle prior to their shipment to foreign countries, thus, so far as possible, assuring the shipment of only such cattle as were free from tuberculosis.

The number of animals of various kinds inspected for export was as shown in Table 3.

TABLE 3.—*Inspection and testing of animals for export*

Kind of animals	To Canada	To other countries		Total	Kind of animals	To Canada	To other countries		Total
		American	Canadian [1]				American	Canadian [1]	
Cattle	1,390	4,852	935	7,177	Mules	363	5,080	.....	5,443
Swine	27	232	.....	259	Asses	.....	10	.....	10
Sheep	1,064	1,966	.....	3,030					
Goats	30	35	.....	65	Total	4,265	12,787	937	17,989
Horses	1,391	612	2	2,005					

[1] Animals of Canadian origin exported through United States ports.

The tuberculin test was applied to practically all of the cattle forwarded to Canada for breeding or dairy purposes. A large percentage of the horses and mules destined to that country were mallein tested and sheep for purposes other than immediate slaughter were generally dipped twice under supervision of a bureau inspector in accordance with a requirement of the Canadian Government. With few exceptions swine exported to Canada were immunized against hog cholera before shipment.

In order to assure the fitting of vessels in a way to accomplish the transportation of livestock in a safe and humane manner, inspections were made of 278 vessels before their clearance to foreign ports.

DIVISION OF HOG-CHOLERA CONTROL

Activities in the control of hog cholera were conducted by the Division

of Hog-Cholera Control, under U. G. Houck, chief, along lines similar to those of recent years. During the unusual prevalence of hog cholera in the fall of 1926, assistance was rendered to swine owners in diagnosing the disease and checking its spread. This service proved to be very effective in confining the extent of outbreaks and bringing them under control.

During the year approximately 37 veterinarians were maintained in the field. In connection with regular educational agencies, 661 meetings were attended, and 480 addressed. A total of 63,523 farmers and others interested in hog-cholera control attended these meetings.

Veterinary practitioners consulted bureau inspectors in 11,395 cases to obtain advice and assistance in the diagnosis of swine diseases and the application of the serum treatment; 370 herds numbering 13,822 hogs were treated in cooperation with these veterinarians.

A total of 25,004 farm visits were made during the year to investigate conditions and to render assistance to swine growers in disease problems. In the course of these visits 4,305 cases of hog cholera and 1,542 cases of other diseases in swine were diagnosed. The number of premises quarantined owing to the presence of hog cholera was 1,832, and of these 744 were cleaned and disinfected during the year.

Demonstrations of hog-cholera-control methods were conducted among 4,493 herds and 84,105 hogs were treated in these demonstrations, at which 11,492 persons were present. In sections where no veterinary services were available, 42 laymen were trained in the use of the preventive-serum treatment.

The number of hog-cholera outbreaks reported from all sources was 11,555. However, since the activities of the division are restricted to certain portions of States and do not cover all of the swine-raising districts, the number of outbreaks reported is considerably less than the total number of outbreaks that occurred throughout the year.

MEAT-INSPECTION DIVISION

The work of the Federal meat-inspection service, conducted under R. P. Steddom, chief, shows an increase of approximately 4 per cent in the total number of animals slaughtered as compared with the preceding year, as well as an increase of approximately 4 per cent over the average total number of animals slaughtered during the preceding 10-year period.

GENERAL MEAT INSPECTION

Inspection was conducted at 863 establishments in 258 cities and towns, as compared with 913 establishments in 259 cities and towns during the fiscal year 1926. Inspection was inaugurated at 25 establishments and withdrawn from 64, as compared with 47 and 78, respectively, during the preceding year. Inspection was withdrawn from 58 of these establishments on account of the discontinuance of slaughtering, interstate, or regular business or upon request, and from 6 on account of violation of the regulations.

ANTE-MORTEM AND POST-MORTEM INSPECTIONS

The ante-mortem and post-mortem inspections are given in Tables 4 and 5.

TABLE 4.—*Ante-mortem inspection of animals*

Class of animals	Passed	Suspected [1]	Condemned [2]	Total
Cattle	9,753,042	293,281	28	10,046,351
Calves	5,067,638	7,562	7	5,075,207
Sheep	12,890,083	4,542	7	12,894,632
Goats	30,392	45		30,437
Swine	42,493,924	117,666	4,421	42,616,011
Horses	42,621	14	252	42,887
Total	70,277,700	423,110	4,715	70,705,525

[1] This term is used to designate animals suspected of being affected with disease or condition that may cause condemnation in whole or in part on special post-mortem inspection.
[2] For additional condemnations, see Tables 5 to 8, inclusive.

TABLE 5.—*Post-mortem inspection of animals*

Class of animals	Passed	Condemned	Total
Cattle	9,966,129	83,460	10,049,589
Calves	5,069,453	10,609	5,080,062
Sheep	12,877,602	16,414	12,894,016
Goats	30,363	74	30,437
Swine	42,476,852	173,591	42,650,443
Horses	42,467	168	42,635
Total	70,462,866	284,316	70,747,182

Tables 6 and 7 show the diseases for which condemnations were made on ante-mortem inspection.

TABLE 6.—*Diseases and conditions for which condemnations were made on ante-mortem inspection*

Cause of condemnation	Cattle	Calves	Sheep	Swine	Horses
Abscess	2			74	
Arthritis				3	
Emaciation	2	1		51	252
Hog cholera				2,457	
Immaturity		2			
Injuries	1	1	4	12	
Metritis				7	
Milk fever		2			
Moribund	8	1		6	
Pregnancy and recent parturition	1			1	
Pneumonia	1			17	
Pyemia and septicemia		1		38	
Pyrexia	11	1	2	1,755	
Shipping sickness			1		
Total	28	7	7	4,421	252

TABLE 7.—*Diseases and conditions for which condemnations were made on post-mortem inspection*

Cause of condemnation	Cattle		Calves		Sheep	
	Carcasses	Parts	Carcasses	Parts	Carcasses	Parts
Actinomycosis	480	96,728	29	1,623		1
Asphyxia	4		6		10	
Blackleg	14		6			
Bone diseases	150	11	130	12	260	138
Caseous lymphadenitis					1,999	9
Congestion	4		1		16	
Contamination		248	4	3		
Cysticercus	169	1,359	26	4	172	2
Dropsical diseases	27		3		37	
Emaciation	6,972		1,610		3,729	
Gangrene	62		27		7	
Hydronephrosis	1				1	
Icterus	93		152		1,123	
Immaturity			3,514			
Injuries, bruises, etc	3,468	625	780	92	715	206
Leukemia	817		23		4	
Melanosis	32	16	49	4	22	
Moribund	9		2		39	
Necrobacillosis	6					
Necrosis	1	1,334			1	2
Parasitic diseases	14	21	1		5	
Phlebitis			54			
Pneumonia, peritonitis, enteritis, pleurisy, etc	10,185		2,169		6,602	
Pregnancy and recent parturition	43					
Rabies	1					
Septicemia, pyemia, uremia, etc	5,323		1,171		1,444	
Sexual odor					2	
Skin diseases	1		2		5	
Texas fever	90		148			
Tuberculosis	53,512	80,952	634	791		
Tumors and abscesses	1,982	4,221	68	542	221	33
Total	83,460	185,515	10,609	3,072	16,414	391

TABLE 7.—*Diseases and conditions for which condemnations were made on post-mortem inspection*—Continued

Cause of condemnation	Goats		Swine		Horses	
	Carcasses	Parts	Carcasses	Parts	Carcasses	Parts
Anthrax			13			
Asphyxia			1,115			
Bone diseases			6,692	75		
Caseous lymphadenitis	5					
Cellulitis			22	847		
Congestion			20			
Contamination			738	2,327	1	
Cysticercus			71			
Dropsical diseases			84			
Emaciation	44		1,125		20	
Gangrene	1		32			
Hog cholera			42,337			
Hydronephrosis			30			
Icterus	1		4,438		1	
Injuries, bruises, etc	4		1,135	10,173	14	3
Leukemia			240		1	
Melanosis			96	3		
Moribund			107			
Necrobacillosis			1			
Necrosis			7	2		
Parasitic diseases			73			
Pneumonia, peritonitis, enteritis, metritis, pleurisy, etc	10		28,812		47	
Pregnancy and recent parturition			11		7	
Septicemia, pyemia, uremia, etc	4		21,772		50	
Sexual odor	3		2,353			
Skin diseases			36			
Strangles					4	
Tuberculosis			59,656	599,873		
Tumors and abscesses	2		2,575	256,633	23	16
Total	74		173,591	869,933	168	19

Table 8 shows the total condemnations on ante-mortem and post-mortem inspections combined.

TABLE 8.—*Summary of condemnations*

Class of animals	Animals or carcasses	Parts	Class of animals	Animals or carcasses	Parts
Cattle	83,488	185,515	Swine	178,012	869,933
Calves	10,616	3,071	Horses	420	19
Sheep	16,421	391			
Goats	74		Total	289,031	1,058,929

In addition, the carcasses of 71,614 animals dead or in dying condition were tanked as follows: Cattle, 4,150; calves, 5,989; sheep, 12,552; goats, 63; swine, 48,585; horses, 275.

INSPECTION OF MEAT AND PRODUCTS

The inspection and supervision of meats and products prepared and processed are shown in Table 9, which is a record only of inspection performed and not a statement of the actual quantity prepared. The record of inspection is sometimes duplicated when the product is reinspected during the different stages of preparation.

TABLE 9.—*Meat and meat food products prepared and processed under supervision*

Kind of product	Inspected	Kind of product	Inspected
	Pounds		*Pounds*
Placed in cure:		Lard oil	7,790,445
Beef	162,689,498	Lard stearin	2,494,613
Pork	2,920,205,654	Compound and other substitutes for lard	535,175,350
All other	23,647,276	Oleo stock and edible tallow	70,446,520
Sausage chopped	765,074,338	Oleo oil	141,895,785
Canned product:		Oleostearin	68,298,387
Beef	212,833,379	Oleomargarin	148,384,048
Pork	29,901,667	Miscellaneous	1,714,896,172
All other	5,724,001	Horse meat:	
Sterilized product:		Cured	4,655,574
Beef	3,159,037	Canned	673,922
Pork	7,470,041	Miscellaneous	4,122
All other	20,077		
Pork to be eaten uncooked	49,297,296	Total	8,566,443,671
Meat extract	362,579		
Lard	1,691,343,890		

The following quantities of meat and meat food products were condemned on reinspection and destroyed for food purposes on account of having become sour, tainted, unclean, rancid, or otherwise unwholesome; Beef, 2,666,667 pounds; pork, 6,264,640 pounds; mutton, 44,270 pounds; veal, 31,515 pounds; goat meat, 265 pounds; horse meat, 1,775 pounds; total, 9,009,132 pounds.

Market inspection, to facilitate interstate deliveries of meats and products, was conducted in 26 cities.

MEATS AND PRODUCTS CERTIFIED FOR EXPORT

A total of 89,154 official meat-inspection certificates were issued to cover the exportation of the following products: Beef and beef products, 168,635,698 pounds; mutton and mutton products, 2,639,710 pounds; pork and pork products, 1,000,933,265 pounds; horsemeat products, 5,116,704 pounds; total, 1,177,325,377 pounds. There were also issued 4,629 certificates covering the exportation of 79,707,034 pounds of inedible animal products.

EXEMPTION FROM INSPECTION

The provisions of the meat-inspection law requiring inspection do not apply to animals slaughtered by a farmer on the farm or to retail butchers and dealers supplying their customers. The retail butchers and dealers, however, in order to ship meat and meat food products in interstate or foreign commerce, are required to obtain certificates of exemption. The number of such certificates outstanding at the close of the fiscal year was 1,764. During the year 116 certificates were canceled, 86 on account of dealers' retiring from business or ceasing to make interstate shipments, 20 on account of change in address, 6 for insanitary conditions, 2 for violations of the meat-inspection regulations, and 2 on account of handling inspected meats only.

During the year 42,020 shipments were made by retail butchers and dealers holding certificates of exemption, as compared with 34,903 shipments during 1926. The shipments of the year covered products as shown in Table 10.

TABLE 10.—*Shipments by retail butchers and dealers under certificates of exemption*

Product	Carcasses	Pounds	Product	Carcasses	Pounds
Carcasses:			Carcasses—Con.		
Beef (350 quarters)	87	38,227	Cured, meats	----------	393,315
Veal	25,862	2,187,450	Lard	----------	20,961
Sheep	624	27,475	Sausage	----------	84,013
Swine	436	16,754	Miscellaneous (scrapple, lard substitutes, suet, headcheese, etc.)	----------	57,640
Beef, fresh	----------	1,342,021			
Veal, fresh	----------	226,968			
Mutton, fresh	----------	263,738			
Pork, fresh	----------	125,294	Total	27,009	4,783,856

During the year 57,417 interstate shipments were made of meat and meat food products from animals slaughtered by farmers on the farm, as compared with 61,074 shipments made in the fiscal year 1926. The products composing these shipments are shown in Table 11.

TABLE 11.—*Shipments of farm-slaughtered products under exemption from inspection*

Product	Carcasses	Pounds	Product	Carcasses	Pounds
Carcasses:			Carcasses—Con.		
Beef (352 quarters)	88	47,699	Cured meats		350,377
Veal	76,654	6,227,683	Lard		31,185
Sheep	4,425	149,557	Sausage		88,286
Swine	2,094	268,027	Miscellaneous (scrapple, livers, mincemeat, head-cheese, etc.)		8,231
Beef, fresh		15,790			
Veal, fresh		12,639			
Mutton, fresh		3,098			
Pork, fresh		90,699	Total	83,261	7,293,271

INSPECTION OF IMPORTED MEATS

Table 12 shows the inspection of imported meat and meat food products for the fiscal year.

TABLE 12.—*Imported meat and meat food products inspected and passed*

Country of origin	Fresh and refrigerated meats	
	Beef	Other classes
	Pounds	*Pounds*
Argentina [1]	1,185,072	1,795,708
Australia	29,544	82,213
Brazil [1]		1,171
Canada	13,567,166	20,540,848
Uruguay [1]	174,361	25,080
Other countries		63,661
Total	14,956,143	22,508,681

TABLE 12.—*Imported meat and meat food products, etc.*—Continued

Country of origin	Cured and canned meats	Other products	Total weight
	Pounds	*Pounds*	*Pounds*
Argentina	17,493,572	517,685	20,992,037
Australia	145	182,605	294,507
Brazil	1,784,819		1,785,990
Canada	9,598,593	2,893,330	46,599,937
Uruguay	13,010,945	167,648	13,378,034
Other countries	1,826,533	1,693,473	3,583,667
Total	43,714,607	5,454,741	86,634,172

[1] No fresh or frozen meat was received after Jan. 1, 1927.

Table 13 shows the quantities of foreign meat and products excluded from the country because of unsoundness, presence of prohibited preservative, or other failure to comply with the regulations.

TABLE 13.—*Imported meat and meat food products condemned and refused entry*

Product	Condemned	Refused entry	Product	Condemned	Refused entry
	Pounds	*Pounds*		*Pounds*	*Pounds*
Beef	11,075	1,637	Pork	21,079	33,276
Veal	463				
Mutton	65	1,235	Total	32,682	36,148

INSPECTIONS FOR OTHER BRANCHES OF THE GOVERNMENT

By request of other branches of the Government, reinspections of meat and meat food products to determine whether they remained wholesome and conformed to certain specifications were made during the year as shown in Table 14.

TABLE 14.—*Inspections for other branches of the Government*

Branch of Government	Passed	Rejected	Branch of Government	Passed	Rejected
	Pounds	*Pounds*		*Pounds*	*Pounds*
Navy Department	61,818,870	1,618,940	Veterans' Bureau	289,119	11,503
Marine Corps	2,802,013	28,461	Coast Guard	681,306	415
War Department	201,537	9,380	Penitentiaries	316,164	75,525
Interior Department (Indian Affairs)	536,700		Total	66,981,866	1,756,215
Public Health Service	336,157	11,991			

MEAT-INSPECTION LABORATORIES

Laboratory analyses and examinations of meats and meat food products and of substances used in connection with their preparation were continued in the meat-inspection laboratories situated in the several districts throughout the country.

The total number of samples analyzed was 43,894 of which 642 represented meat and meat food products offered for importation. Samples of 2,387 domestic and 122 foreign products were found not to be in accordance with the regulations.

Samples of water supplies, curing materials, spices, condiments, cereals, coloring materials, denaturing oils, etc., were examined. Of 2,118 samples of water 458 showed evidence of pollution.

The water content was determined in a large number of samples of smoked and cooked sausage. Results show that the quantity of added water in sausage of this type was within the limit set by the regulations at practically all official establishments.

Laboratory studies showed that the water content of canned sausage can be readily and effectively controlled by the manufacturer.

LABELING MEAT AND PRODUCTS

There were approved 11,328 labels for meat and meat food products, and 298 were disapproved on account of failure to meet the requirements.

Effort was made toward the elimination from the files of labels on metal. This is possible by the acceptance of actual reproductions of lithographed or embossed labels on paper or cardboard.

It was required that samples of all labels on imported products be forwarded to the Washington office for review. The majority of these labels are printed in foreign languages, and it is important to effect prompt transliteration at a central point.

Recent activities by the department and State agricultural organizations have stimulated the production of baby beef and prompted the industry to seek authority to apply the term "baby beef" to carcasses for identification by consumers. In order to prevent abuses, it was necessary to adopt a definition for the guidance of inspectors in supervising the application of the term.

Investigation was conducted to determine whether garlic or knoblauch sausage is cooked by the consumer previous to use. As a result, the product was placed in the category of pork products consumed without cooking, and instructions were issued for its treatment for the destruction of possible live trichinae.

PATHOLOGICAL DIVISION

The investigation of diseases of animals, the study of the poisoning of livestock by plants, and the examination of viruses, serums, and other remedies used in treating or preventing diseases in domestic animals were continued under the direction of John S. Buckley, chief.

DIAGNOSIS AND CONTROL OF DISEASES

GLANDERS

Cooperative work for the control and eradication of glanders in the various States was continued. The complement-fixation test was applied to 114 samples of serum from animals suspected of being affected with or exposed to the disease, 8 of which gave positive reactions.

DOURINE

In the course of the campaign for the control and eradication of dourine 9,364 samples of blood serum from horses in districts where dourine is present or suspected were subjected to the complement-fixation test, and

703, or approximately 7.5 per cent, gave positive reactions.

TESTING ANIMALS FOR IMPORT

Blood serum from 30 horses offered for import was subjected to the complement-fixation test for glanders and trypanosomiasis before the animals were admitted. The same test was also applied to 11 camels for trypanosomiasis before admission, all proving negative.

RESEARCH ON DISEASE PROBLEMS

BOVINE INFECTIOUS ABORTION

During the early part of last year an experiment was undertaken to determine whether calves may be immunized against infectious abortion in such a manner as to enable them to resist the disease when they become mature and are bred. Twenty calves were procured for this experiment, twelve of which were subcutaneously injected with abortion vaccine (suspensions of living abortion bacteria) when approximately 6 months of age. It was proposed to use the remaining 8 calves as controls. Unthriftiness and accidents reduced the number of the experimental calves to 16 before they became of breeding age.

The experiment has now progressed until but two vaccinated heifers have yet to complete their gestation periods. There is cause at present for believing that calfhood vaccination may be reasonably effective in the prevention of abortion losses inasmuch as 9 of the 11 vaccinated animals at present in the experiment have already produced vigorous calves following *Bacterium abortus* exposure of sufficient intensity to cause 3 of the 5 controls to abort.

The presence of *B. abortus* was demonstrated in the colostrum of but one vaccinated animal at time of parturition. In no case could the presence of the abortion organism be established in the placentae or uterine fluids of the remaining eight vaccinated heifers which have completed their periods of pregnancy.

The presence of *B. abortus* was demonstrated in the fetuses and colostrum of three of the five control heifers and a fourth control heifer developed a positive reaction to abortion disease approximately 50 days after calving.

The results of the experiment suggest that calfhood vaccination may perhaps be as effective in conferring immunity as the vaccination of heifers shortly before breeding. In that case artificial immunization is rendered somewhat more practicable for the owners of herds who find it impracticable to maintain accurate breeding records.

Further studies have been made of the practicability of eradicating the disease from herds by the segregation of reactors to the agglutination test. In one herd, which consisted of approximately 200 head of dairy animals, 65 reactors were removed on the first test to separate premises well away from the rest of the herd and a thorough cleaning and disinfection of the premises carried out. Tests were made at 60-day intervals. On the second test, 6 additional animals had developed reactions; on the third, 8; on the fourth, 7; on the fifth, 2; on the sixth, 1; and on the seventh, none—which made it necessary to remove in all 89 animals. The objective was seemingly attained in this herd, but possibly at too high a cost to justify its general adoption. In a second herd of approximately 100 head of dairy cattle where the same method of combating the disease was used the results have been somewhat more encouraging from the standpoint of practicability inasmuch as by the removal to separate premises of about 12 per cent of the herd the spread of the disease has appeared to be effectively checked.

In an endeavor to become more definitely informed as to whether the pathogenic action of *B. abortus* for animals is lessened or enhanced by deficiencies in diet, preliminary studies bearing upon this problem have been pursued by the Pathological and Biochemic Divisions working cooperatively. The procedures thus far have consisted mainly in feeding white rats for extended periods on controlled rations. Failure was experienced in demonstrating that the behavior of *B. abortus* infection within the animal was influenced to any appreciable degree by a deficiency of any of the different food elements mentioned.

POULTRY-DISEASE INVESTIGATIONS

Numerous pathological specimens were received from various sections of the country, among which were observed such diseases as chicken pox, diphtheria, roup, infectious bronchitis, typhoid, tuberculosis, coccidiosis, and bacillary white diarrhea in chickens, blackhead in turkeys, and sarcosporidiosis in the breast muscles of Mallard ducks.

Further observations with reference to a widespread disease of pullets and cockerels, manifested by paralysis, emaciation, and blindness, led to the tentative conclusion that the disease is a chronic form of coccidial enteritis.

TESTS WITH TUBERCLE BACILLI

In an attempt to find some chemical agent that would attenuate tubercle bacilli without completely killing them, with a view to using the bacilli after attenuation as immunizing agents on cattle, tests were made with toluol and butylidene-diphenol.

Tubercle bacilli were rubbed into suitable preparations of these agents and then allowed to remain in them for 24 hours. After this guinea pigs were inoculated with various amounts of the solution containing the attenuated tubercle bacilli, but in no instance was any value noted, as all of the test animals died of extensive tuberculosis.

CANINE TUBERCULOSIS

A case of tuberculosis was encountered in a 5-months-old dog which had been captured as a stray on the streets of Washington, D. C. The animal had developed symptoms suspicious of the catarrhal type of distemper—i. e., running at the eyes and nose and elevated temperature. However, there was no loss of appetite or any dullness. A swelling about the size of a hen's egg appeared on the right side of the upper part of the throat and in a few days the skin over this region sloughed, allowing an oozing of bloodstained fluid. The animal remained bright and retained its appetite, but fell off considerably in flesh and showed increasing symptoms of pneumonia. In the course of a few days the dog died. At autopsy the right retropharyngeal lymph gland was found enlarged, with its center caseous. There was extensive periglandular inflammation with necrosis of the surrounding tissues, including the skin. The bronchial, suprasternal, and mesenteric lymph glands were enlarged and caseous and contained numerous tubercle basilli.

NODULAR LESIONS OF SWINE SPLEENS

Studies were completed on the cause of peculiar nodular lesions in the spleens of swine, no other lesions being found in the carcass of animals showing spleens so affected.

The laboratory findings in cases examined indicate that such lesions are caused by antinomyces infection. A paper covering this work was submitted for publication.

MONTANA SHEEP DISEASE

Investigations of the cause of chronic, progressive pneumonia of sheep, prevalent in Montana, have been carried on for several years. This work, now completed, has included bacteriological and histological studies of tissues of the affected sheep, and also various animal-inoculation experiments.

LEUKEMIA IN CATTLE

Experiments pertaining to the cause of leukemia of cattle have been completed. This work covered a period of more than a year and consisted of bacteriological and histological studies of the blood and other tissues affected, and various animal-inoculation experiments. All findings from an etiological standpoint were negative.

STUDIES OF BOVINE MAMMARY GLANDS

Histological studies of bovine mammary glands, with regard to development in animals of various ages, changes, and variations noted in different types of animals during lactation period, are under way, in cooperation with the Bureau of Dairy Industry.

WARTY GROWTH OF CATTLE

An investigation of the cause of papillomata, or warty growths of cattle, undertaken during the last year, is being conducted. This work includes attempts to reproduce the warty growths through experimental inoculations, and also cultural experiments to determine the etiology of such growths.

RABIES

The number of cases of animals examined for rabies continued to be extremely large. The abnormal number of rabid animals is attributable to an insufficient enforcement of the muzzling regulations. The District of Columbia contributed most cases, but the material included also cases from the vicinity of Washington, in Maryland and Virginia, besides some isolated cases from Pennsylvania and West Virginia.

Two hundred and thirty-six suspected cases were received and submitted to laboratory examination. These included 165 positive cases of rabies in dogs, of which 104 were from

the District of Columbia. Besides these, 15 cats, 9 cows, 3 hogs, and 1 steer from the outlying areas and the District were examined and proved to be rabid. A total of 148 persons, including 31 owners of dogs, 45 children, and 72 outside persons were bitten by these affected animals, or exposed to the disease by cuts or scratches on their hands. In every instance in which a person was bitten, laboratory-animal inoculation was undertaken when the microscopic examination failed to show the presence of rabies.

VACCINATION OF DOGS AGAINST RABIES

Experimental work on the vaccination of dogs against rabies was conducted. The efficacy of a single injection of a killed vaccine as a prophylactic against rabies is being studied and while the work has been in progress but a short time, limited evidence indicates that this method of vaccination in a number of cases was unable to protect dogs against a certain method of experimental infection.

FOOT-AND-MOUTH DISEASE

Work on the report of the department's foot-and-mouth disease commission occupied a considerable portion of the time of one of the members of the staff of the Pathological Division, who served on the commission. The complete report of the commission is now in course of publication.

FORAGE POISONING OF HORSES

The affection commonly known as forage poisoning did not appear to be so prevalent as in past seasons. A strain of *Clostritium botulinum*, type B, was recovered from the feces of a horse suffering from this disease in eastern Virginia. The animal presented a typical clinical picture of forage poisoning, and succumbed after a five-day illness.

Two mules were successfully immunized against botulinum toxin by means of three subcutaneous injections of botulinum antitoxin. The latter product was prepared by adding to a quantity of several months' old type B toxin sufficient formalin to make a 0.7 per cent solution and incubating at 37° C. for seven days. When injected with the toxin both of the treated mules lived, and showed no evidence of any reaction to the injection. A control animal to which the toxin was also given died of botulism in about 30 hours.

ANIMALS FROM THE NATIONAL ZOOLOGICAL PARK

Thirty-one animals from the National Zoological Park were autopsied in an effort to determine the cause of death, which was established in 29 cases.

TESTING BIOLOGICAL PRODUCTS

The bureau received for examination 41 samples of biological products prepared under United States veterinary licenses. Tests of the products resulted in finding 10 of the samples unsatisfactory for one or more of the following causes: Bacterial contamination, lack of potency, and presence of injurious substances. In one instance a certain lot of natural aggressin was found contaminated with type C botulinum toxin. A dose of 0.04 cubic centimeters of this product injected subcutaneously proved fatal to a 400-gram guinea pig and 5 cubic centimeters were sufficient to cause the death of a mule. It is possible that the contamination of the product occurred at or shortly after the death of the animal used for producing the aggressin. *C. botulinum*, type C, has been isolated from the larvæ of certain flies and from the soil of some localities. This germ may have gained entrance to the body of the aggressin animal through contact with the soil or through the agency of flies, thus permitting a contamination of the animal-tissue juices. The latter being allowed to stand for from one to five weeks before filtration virtually became a culture of *C. botulinum* and the finished product a highly toxic filtrate.

To insure against a similar occurrence in the future it was recommended that the inoculation of animals for the preparation of aggressin should be done in a fly-proof stable with a concrete floor which had been previously disinfected. Strict aseptic technic should be used in harvesting the product.

TOXICOLOGICAL INVESTIGATIONS

TREMBLES AND MILK SICKNESS

The studies on the chemistry and toxicology of the plants *Eupatorium urticaefolium* and *Aplopappus heterophyllus* were continued. There was isolated from the first plant a complex alcohol which appears to be the substance responsible for trembles, and two other toxic substances, which, however, do not appear to bear any relation to milk sickness. An exten-

sive report of this work is in process of publication. The study of the complex alcohol, which has been named tremetol, is being continued with the veiw of determining its chemical constitution and elucidating the peculiarities of structure that are responsible for the peculiar nature of trembles. An easily performed test for tremetol was developed by which the presence of this substance may be detected. *Aplopappus heterophyllus* also was studied and from it a small quantity of crystalline material was isolated which is probably the active principle, although the quantities so far available do not permit the accurate determination of this point.

A short paper dealing with the occurrence of acidosis in trembles and milk sickness was published in Science, issue of November 5, 1926.

LOCO DISEASE

The chemical study of the loco poison was continued and several new facts were determined. The investigation is being continued.

WILD-TOBACCO POISONING

A sample of *Nicotiana attenuata* was analyzed and found to contain true nicotine without the presence of other Nicotiana alkaloids. The quantities of nicotine present in various parts of the plant were determined. The results were presented for publication.

LUPINES

The investigation of lupines was continued. A considerable quantity of *L. perennis* was collected and the alkaloids were isolated from it. One of these has been obtained very pure in the form of a crystalline hydrochloride. Purification and analysis of the other lupine alkaloids previously isolated has been continued.

KARWINSKIA AND DAUBENTONIA

Attempts to locate and isolate the toxic constituents of these plants were continued.

BRANCH LABORATORIES

DENVER

During the year 1,735 specimens, which was 351 more than in the previous 12-month period, were received for examination at the branch pathological laboratory, Denver, Colo.

The cooperative work on tuberculosis with Louise G. Robinovitch is still under process of development—one joint-authorship article has been published, entitled "Contribution to the Study of the Pancreas in Tuberculosis; The Pancreas and Tuberculosis in Guinea Pigs and in Albino Rats." Certain phases of the work are extremely encouraging.

There was continued demand for assistance on poultry problems. A paper entitled "Vaccination for Roup and Its Allied Disorders in Poultry" was published in a poultry paper.

Good results in the treatment of coccidiosis were experienced with powdered catechu in the drinking water—1 heaping teaspoonful to 3 gallons of water.

During the winter a serious loss occured in yearling cattle and a small band of sheep in New Mexico following vaccination with a commercial aggressin against hemorrhagic septicemia. Investigation showed botulism, type C, was the cause of this loss, the organism having apparently gained access to the unfinished product during the process of manufacture.

Investigations with anaerobic organisms continue and there appear to be undiscovered types, heretofore unrecognized, which are responsible for obscure losses in horses, cattle, and sheep.

Records of office calls at the laboratory shows that approximately an average of 100 persons call for assistance monthly, embracing all kinds of trouble.

CHICAGO

The principal function of the branch laboratory at Chicago is to aid the Federal meat-inspection service. Therefore the work consists largely in diagnosing diseased conditions encountered in animals slaughtered under Federal meat inspection throughout the Middle West. The specimens received for diagnoses represented a large variety of diseases and conditions. Three unusual specimens deserve special mention.

A liver of a young hog, weighing 200 pounds, was heavily infested with Echinococcus cysts. This infested liver weighed 19½ pounds and contained many hundreds of cysts ranging in size from one-half inch to about 1 inch in diameter. The cysts were so numerous that the greater portion of the liver consisted of hydatid cysts. About 100 similar cysts were also found in the lungs of the same animal. While Echinococcus cysts are not uncommon in the livers of swine from certain portions of the country, this case was unusual because of the extensive infestation and size of the

liver and the presence of a large number of cysts in the lungs.

Another unusual condition in cattle, encountered several times during the past year as well as in former years, appears as firm, greenish-gray nodules located in the subcutaneous tissues, superficial muscles, lymph nodes, and in some cases in the lungs. This condition is more often found in aged animals in fair condition. The nodules in the subcutaneous fat and lungs are usually spherical, and range in size from one-fourth to 1 inch in diameter, and are sharply differentiated from the surrounding tissue. Those found in the musculature are usually larger, and are not sharply differentiated from the surrounding tissue. Upon microscopic examination of cut and stained sections of these nodules, they are found to be composed almost wholly of eosinophile cells. The nature of this condition is not well understood.

An unusual case of ossification of the lungs of a 3-year-old cow was received at the laboratory. Fully three-fourths of the lung tissue was affected, and calcareous deposits were found in the lining membrane of both auricles and ventricles of the heart, as well as in the lining membrane of the common, anterior, and posterior aortas, which extended for about an inch into their branches. The ossification in the lungs was so extensive that the lungs collapsed only slightly when removed from the pleural cavity. Sections were prepared from the lungs, heart, and aorta. Calcareous deposits with ossification appear to be the result of a disturbed metabolism, in which large quantities of lime salts are present in the circulation.

Investigations concerning the so-called skin lesions in tuberculin-reacting cattle were continued. Tuberculosis was produced in a calf by injecting material from a skin lesion removed from a cow, in which no other lesions of tuberculosis were found. This strengthens the belief that the so-called skin lesions of tuberculosis in cattle are the result of infection by tubercle bacilli.

As in former years, a number of museum specimens were prepared for exhibition purposes, showing the manifestations of various diseases in tissues.

In addition to aiding the meat-inspection service, assistance has been rendered to medical colleges, veterinarians, stockmen, and others seeking assistance.

OMAHA

The total number of specimens examined at the South Omaha branch laboratory was 862.

Specimens from tuberculin reactors showing no lesions on post-mortem examination numbered 669. Of these, 26 were found to contain acid-fast bacilli, while in the remaining 643 none were found.

Specimens of tissue other than that from "reactors" numbered 193. Diagnoses were made of the pathological condition present, 20 specimens being negative.

STOCK-POISONING PLANTS

Investigations of stock-poisoning plants were continued on the same general lines as in past years. A large part of the experimental work was done at the experiment station, near Salina, Utah, the station being kept open from June 1 to September 30.

Work on the milkweed *Asclepias californica* may be considered complete. It may be very slightly poisonous, but evidently has no importance as a stock-poisoning plant. *A. albicans* has been found to be distinctly poisonous, producing effects similar to those caused by some of the other milkweeds.

A. subulata is a distinctly poisonous plant, resembling *A. albicans* in its effects. More work upon both these plants is necessary.

Asclepiodora decumbens is suspected of being poisonous to sheep, especially in Arizona, and has been proved to have distinct, poisonous properties.

Astragalus nothoxys is a true loco plant, but the work has not been completed, on account of lack of material.

Work on *Hypericum perforatum* has given very indefinite results, although the plant has been shown to be distinctly poisonous.

The work on the "rayless goldenrod" *Aplopappus coronopifolia* is considered complete. It was found to be about equally poisonous with *A. wrightii*. Further work on *A. heterophylla*, which has been suspected by some of being a species distinct from *A. wrightii*, has shown that its effects are practically the same.

Karwinskia humboldtiana, called "coyotillo" in Texas and Mexico, has been of special interest because of the peculiar paralysis produced by it in domestic animals. A bulletin on the subject has been presented for publication.

The wild tobaccos have been under investigation in preceding years, because of reported losses of range animals. Work on *Nicotiana trigonophylla* is considered as completing, so far as practical purposes are considered, the necessary work on *N. trigonophylla* and *N. attenuata*. A bulletin covering the work on these plants is in course of publication.

Work on *Senecio integerrimus*, while completed so far as sheep are concerned, will be continued with reference to its effect on cattle.

The practical work on *Stipa vaseyi*, commonly known as "sleepy grass," is considered complete, but experimental work with the green plant is planned for the coming year.

Recent experiments demonstrated conclusively the poisonous properties of the plant *Triglochin maritima* for cattle and sheep, and determined the dosage. The toxic effect is due to the presence of hydrocyanic acid, and the experiments indicated that this disappears from the plant in the process of drying, contrary to published statements that the dry plants of *T. maritima* are more toxic than the green. Accordingly hydrocyanic-acid determinations will be made on the plant in its various stages.

TICK-ERADICATION DIVISION

The work of suppressing splenetic or Texas fever of cattle and the eradication of the tick which transmits that disease was continued under the direction of R. A. Ramsay, chief, in cooperation with the State and county officials in the infested Southern States.

TICK ERADICATION

The field activities in this project were continued under the direction of nine field stations, which at the close of the fiscal year had a total field force of 332 veterinarians and other employees working in cooperation with 555 State inspectors and 176 county employees.

Under the supervision of the cooperating forces 16,533,421 inspections or dippings of cattle were conducted, and more than 15,000 vats were used in these official dippings. The bureau has continued the policy of giving special attention to the completion of tick eradication in areas released from Federal quarantine but in which a small amount of infestation remained. It has also urged, as the most satisfactory and economical manner of conducting active tick eradication, that the areas in which systematic work is undertaken be so prepared and such concentration of effort made as to insure release from quarantine following one season's work.

During the active tick-eradication season of 1926 the ticks were completely eradicated from 40 additional released counties; and during the fiscal year the following areas were released from Federal quarantine: 4 counties and parts of 2 counties in Arkansas; part of 1 county in Florida; 6 counties and part of 1 county in Texas; and 2 counties and part of 1 county in Virginia. During the same period the following areas were requarantined: 1 parish and parts of 2 parishes in Louisiana and 1 county in Texas.

Table 15 shows the progress made in tick eradication since its beginning, in 1906, and gives the status of the work at the close of the fiscal year.

TABLE 15.—*Tick-eradication results, July 1, 1906, to June 30, 1927*

State	Counties quarantined		Counties released to June 30, 1927	Released counties tick-free				
	July 1, 1906	June 30, 1927		Nov. 1, 1922	Nov. 1, 1923	Nov. 1, 1924	Nov. 1, 1925	Nov. 1 1926,
Alabama	67	5	62	15	26	41	49	49
Arkansas	75	29	46	16	21	34	31	41
California	15	0	15	15	15	15	15	15
Florida	67	54	13	3	3	1	7	12
Georgia	158	0	158	101	119	138	149	151
Kentucky	2	0	2	2	2	2	2	2
Louisiana	64	42	22	3	3	4	4	11
Mississippi	82	23	59	37	47	54	47	47
Missouri	4	0	4	4	4	4	4	4
North Carolina	73	0	73	40	46	53	65	73
Oklahoma	61	4	57	35	47	49	52	55
South Carolina	46	2	44	29	35	36	40	40
Tennessee	42	0	42	41	41	42	42	42
Texas	198	88	110	44	49	56	69	72
Virginia	31	1	30	(1)	(1)	(1)	25	27
Total	985	248	737	385	458	529	601	641

[1] Inactive from Nov. 1, 1922, to Nov. 1, 1924.

SHIPMENTS FROM QUARANTINED AREAS

There were 387,322 southern cattle shipped from the quarantined areas to market centers for immediate slaughter during the year.

In the movement of this class of cattle from the quarantined area for purposes other than slaughter, 278,687 head were inspected or dipped in the field, for which 4,750 certificates were issued authorizing their interstate movement. At public stockyards 36,262 cattle were dipped and 3,066 certificates issued authorizing their movement as noninfectious.

FLOODS MAY AID IN FREEING LAND

In 1927 floods in the Mississippi Valley inundated sections, particularly in Louisiana, of the quarantined and tick-infested areas forcing the removal of all cattle and other livestock and, by submerging or burying under a deposit of silt, destroyed the ticks that infested the land in these flooded areas. The hurried emergency movement of tick-infested animals from these quarantined areas has resulted, in a few instances, in carrying ticks to free areas. It is hoped, however, that this may be more than offset by taking advantage of conditions brought about by the flood, and that tick eradication may be advanced in a considerable area at comparatively slight expense by restocking the flooded lands with tick-free cattle. As the fiscal year closes the bureau is urging this procedure and is offering all assistance at its disposal to gain these results.

MOTION PICTURES IN STIMULATING TICK ERADICATION

The use of motion pictures as a means of molding favorable sentiment for this work by showing the benefits that may be derived and the proper methods to be followed continued to give very satisfactory results with two portable motion-picture outfits. Exhibitions were given in rural districts of the tick-infested sections in the States of Alabama, Arkansas, Florida, and Texas. There were 351 exhibitions given to rural audiences aggregating 55,454 persons.

A new motion-picture film, Southern Cattle Yesterday and To-day, prepared by the department motion-picture laboratory during the year, has been a great acquisition to this line of work. The picture contains views taken in Virginia, North Carolina, South Carolina, Georgia, Florida, and Mississippi, showing the progress made in the production of beef and dairy cattle in areas formerly tick infested, also views of a well-equipped packing house and stockyards, creameries, and milk factory in former ticky areas, showing that there is a ready home market at all times for well-prepared products from better bred and fed livestock. This picture was viewed by thousands of people in rural communities where the tick existed and good livestock did not. As a result the bureau has received many inquiries for means of bringing about better conditions on southern farms.

TUBERCULOSIS-ERADICATION DIVISION

The cooperative work of tuberculosis eradication, under the direction of J. A. Kiernan, chief, was continued, progress being highly satisfactory. Cooperation by the State livestock sanitary officials of the 48 States and of the Territories of Alaska and Hawaii was excellent. Particular attention was paid to certain phases of the work, including the control of avian tuberculosis and the marketing and salvaging of animals which reacted to the tuberculin test.

On an average, 208 regularly employed bureau veterinarians were engaged in the work under the supervision of the inspectors in charge of 44 field offices. The livestock sanitary officials of the respective States employed an average of 325 veterinarians, including a limited number employed by municipalities. In addition, approximately 315 regularly employed veterinary inspectors were engaged by the many counties under the intensive-area plan. In all there were 848 veterinarians engaged in the work regularly throughout the year. Contrary to previous years, the regularly employed State veterinarians show the most marked increase in numbers.

Appropriations for the year, both State and Federal, were increased over the preceding fiscal year, principally for indemnity purposes. The Federal appropriation was $4,653,000, of which $975,000 was allotted for operating expenses and $3,678,000 for indemnifying owners of condemned cattle. This was an increase of approximately $1,100,000 for indemnity purposes over the previous year. The combined State appropriations were approximately $13,000,000. As a result of this increase of funds the number of cattle tested was 7 per cent more than the preceding year. The general plan of the work, including eradication of tuberculosis under the accredited-herd

plan, the area plan, the eradication of the disease from swine, the investigations relative to interstate shipment, and tuberculosis in fowls, was continued.

ACCREDITED TUBERCULOSIS-FREE HERDS

Although greatest attention was again given to the area project, tuberculin testing under the accredited-herd plan was conducted in all States. At the conclusion of the year there were listed as fully accredited 130,476 herds, containing 1,885,072 cattle, an increase of 34,084 herds, containing 307,985 cattle. In addition, 1,533,518 herds, containing 12,741,520 cattle, had passed one test in the process of becoming accredited. This was an increase of 229,086 herds and 2,083,261 cattle. The total under supervision at the end of the year numbered 1,817,514 herds, containing 17,600,380 cattle, and there were on the waiting list 482,719 herds, containing 4,680,171 cattle.

In connection with this and the area eradication work, reported later, the tuberculin test was applied to 871,561 herds, containing 9,700,176 cattle, including those cattle tested for interstate shipment by bureau and approved veterinarians, of which 285,361 cattle, or 2.9 per cent were condemned as diseased.

Table 16 shows the progress of the work annually, including the cattle tested under both plans and the number and percentage of the reactors. It will be noted that the accredited-herd work began in 1917, and the area plan in 1922.

TABLE 16.—*Progress of tuberculin testing under accredited-herd and area plans, 1917–1927*

Year ended June 30—	Cattle tested					Modified accredited areas	Herds accredited [1]	Herds passed one test [1]	Herds under supervision [1]
	Accredited-herd plan	Area plan	Total	Reactors found	Per cent of reactors				
	Number	*Number*	*Number*	*Number*		*Number*	*Number*	*Number*	*Number*
1917	20,101		20,101	645	3.2				
1918	134,143		134,143	6,544	4.9		204	883	
1919	329,878		329,878	13,528	4.1		578	5,652	
1920	700,670		700,670	28,709	4.1		2,588	10,064	
1921	1,366,358		1,366,358	53,768	3.9		4,831	33,215	71,806
1922	1,722,209	[2] 662,027	2,384,236	82,569	3.5		8,015	111,719	140,376
1923	1,695,662	1,765,187	3,460,849	113,844	3.3		12,310	150,748	187,915
1924	1,865,863	3,446,501	5,312,364	171,559	3.2	38	19,747	216,737	305,809
1925	2,008,526	4,991,502	7,000,028	214,491	3.1	51	24,110	392,740	414,620
1926	1,989,048	6,661,732	8,650,780	323,084	3.7	109	24,009	382,674	435,840
1927	2,522,791	7,177,385	9,700,176	285,361	2.9	149	34,084	229,086	261,148
Total	14,355,249	24,704,334	39,059,583	1,294,102	3.3	347	130,476	1,533,518	1,817,514

[1] The figures in these columns represent net increases at the close of each year.
[2] Testing during six months.

The participation of accredited practicing veterinarians in the cooperative work was further increased. Records show that this group tested under the plan 55,204 herds containing more than 933,000 cattle, an increase of more than 18 per cent over the preceding year.

Reference was made in the previous year's report to a survey made to ascertain the number of towns and cities in the United States which had municipal ordinances requiring the tuberculin testing of all cattle furnishing milk for consumption in their respective communities. This summary included 1,249 such towns and cities and awakened such an interest in this phase of the tuberculin-testing work that a considerable number of other municipalities enacted legislation along similar lines. Therefore an additional survey was regarded as necessary, and it is being made at the present time in cooperation with the Bureau of Dairy Industry and the United States Public Health Service.

The work in Hawaii and Alaska was continued in cooperation with the officials of those Territories. A summary from Hawaii shows that from 1922 to 1927, inclusive, nearly 50,000 cattle were tested, and that the incidence of the disease was greatly reduced. A bureau representative again conducted a series of tests in Alaska at the request of the Territorial governor.

ERADICATION OF TUBERCULOSIS FROM AREAS

The highly favorable results obtained from the intensive area work continued to demonstrate the value

and efficiency of that plan. Rapid progress was made in the eradication of the disease from cattle within circumscribed areas. Approximately 74 per cent of the total number of cattle tested in the work of tuberculosis eradication were tested under this plan. At the conclusion of the fiscal year 953 counties had engaged in area work. This is an increase of 197 counties, or 26 per cent, over the number for the preceding year. The counties continued to indicate their interest in the work by the expenditure of approximately $1,207,000, an increase of more than $139,000. The plan of establishing counties as modified accredited areas under Department of Agriculture certification was continued. At the conclusion of the year there were 347 such areas, not including 14 towns, a part of one other county, and the District of Columbia. This is in comparison with 198 such areas for the previous year.

A study of the statistics shows that at the completion of the year approximately 11.3 per cent of the total counties in the United States were in the modified accredited class, and that, including the modified counties, 31 per cent of the entire number of counties in the United States were engaged in the project.

A number of State legislatures enacted legislation improving existing laws or enacted entirely new legislation which will enable more rapid progress. The status of area work is shown in Table 17.

TABLE 17.—*Status of tuberculosis eradication from county areas at close of fiscal year ended June 30, 1927*

State	Counties completing one or more tests of all cattle[1]	Counties intensively engaged in testing	Total counties engaged[1]	Modified accredited counties	Cattle tested during year
Alabama	0	3	3	0	2,556
Arizona	0	14	14	0	47,531
California	2	2	4	2	54,138
Colorado	0	2	2	0	6,327
Connecticut	0	4	4	0	6,136
Delaware	1	0	1	0	
District of Columbia	1	0	1	0	669
Florida	4	0	4	3	
Georgia	2	1	3	0	1,873
Idaho	17	11	28	15	86,583
Illinois	7	64	71	7	685,318
Indiana	31	24	55	21	271,803
Iowa	46	13	59	30	676,562
Kansas	24	0	24	20	225,745
Kentucky	36	12	48	6	75,685
Maine	4	12	16	4	65,930
Maryland	3	5	8	0	75,839
Michigan	55	6	61	42	511,255
Minnesota	17	0	17	9	681,422
Mississippi	1	2	3	0	32,771
Missouri	4	3	7	4	14,761
Montana	[2] 3	2	5	[2] 2	60,697
Nebraska	27	7	34	21	370,532
Nevada	0	13	13	0	15,390
New Hampshire	0	5	5	0	24,838
New Mexico	0	18	18	0	871
New York	13	32	45	4	644,950
North Carolina	82	12	94	82	89,873
North Dakota	19	13	32	19	107,969
Ohio	21	26	47	13	450,871
Oregon	10	14	24	4	113,241
Pennsylvania	14	35	49	9	269,080
South Carolina	3	1	4	3	29,315
South Dakota	4	0	4	3	110,977
Tennessee	3	0	3	3	12,595
Utah	2	21	23	1	62,551
Vermont	[3]	6	6	[3] 0	30,886
Virginia	5	5	10	4	24,623
Washington	2	33	35	0	131,067
West Virginia	7	3	10	5	48,860
Wisconsin	41	19	60	11	1,055,295
Wyoming	0	0	0	0	0
Total	511	443	954	347	7,177,385

[1] Including the District of Columbia.
[2] Not including part of one county.
[3] Not including 14 towns.

STATISTICS OF SLAUGHTER AND INDEMNITY

The market for reactor cattle, established through cooperative efforts, was probably the best ever obtained, as is indicated by the average salvage per head shown in Table 18. Much credit is due State officials and bureau representatives who visited public stockyards, packing houses, and commission agencies relative to this most important phase of the work. The average salvage per head for the 207,830 reactors slaughtered last year was $30.69, which is $6.05, or 25 per cent, larger than the corresponding figure for the preceding year.

TABLE 18.—*Cattle slaughtered, appraised value, indemnity allowed, and salvage realized in work of tuberculosis eradication, fiscal year 1927*

State	Cattle slaughtered	Average appraisal per head	State indemnity	Federal indemnity	Average State indemnity per head	Average Federal indemnity per head	Average salvage per head
	Number	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Alaska	16	191.25	1,554.98	365.00	97.19	22.81	8.91
Arizona	765	135.36	19,561.67	19,561.67	25.57	25.57	22.60
Colorado	325	106.31	6,596.45	6,596.45	20.30	20.30	30.73
Connecticut	5,122	79.08	161,615.88	84,069.67	31.55	16.41	28.38
Delaware	1,578	73.88	40,436.26	26,743.55	25.62	16.95	22.35
District of Columbia	1	90.00		25.00		25.00	15.00
Florida	297	31.58	3,908.59	1,902.52	13.16	6.41	11.81
Hawaii	125	214.74	6,300.00	3,150.00	50.40	25.00	50.20
Idaho	342	39.47	2,462.37	2,462.37	7.20	7.20	19.30
Illinois	36,428	79.64	524,779.35	524,779.35	14.41	14.41	36.57
Indiana	3,586	99.64	79,287.83	71,295.32	22.11	19.88	32.92
Iowa	13,398	93.63	212,484.57	212,484.57	15.86	15.86	34.31
Kansas	2,364	76.78	35,116.51	34,070.41	14.85	14.41	31.93
Kentucky	298	73.77	9,043.12	4,514.39	30.35	15.15	22.27
Louisiana	918	50.15	8,673.17	8,673.17	9.45	9.45	21.12
Maine [1]	746	87.43	44,528.33	14,552.60	59.69	19.51	17.55
Maryland	5,099	77.24	82,806.36	82,806.36	16.24	16.24	28.27
Massachusetts	5,174	140.96	141,610.62	141,610.62	27.37	27.37	32.19
Michigan	6,259	91.90	195,998.00	113,441.61	31.31	18.12	30.95
Minnesota	14,997	61.07	273,897.54	159,416.09	18.26	10.62	29.54
Mississippi	46	77.17	1,104.27	943.60	24.01	20.51	4.07
Missouri	105	188.90	3,908.04	3,908.04	37.22	37.22	32.79
Montana [1]	330	57.82	13,667.45	5,275.00	41.42	15.98	7.12
Nebraska	2,816	92.43	37,460.56	37,460.56	13.30	13.30	34.05
Nevada	70	58.36	1,059.28	911.10	15.13	13.02	16.22
New Hampshire	2,486	78.57	86,404.50	45,630.25	34.76	18.35	23.82
New Jersey	2,350	124.83	72,492.99	58,758.40	30.85	25.00	32.53
New Mexico	13	53.69	232.66	232.66	17.90	17.90	
New York	25,447	112.22	1,622,834.69	397,694.98	63.77	15.63	30.57
North Carolina	163	96.75	3,582.90	3,582.90	21.98	21.98	14.24
North Dakota	1,758	54.00	16,190.08	16,190.08	9.21	9.21	27.74
Ohio	12,628	117.21	300,050.50	300,050.50	23.76	23.76	31.78
Oklahoma	71	93.87	1,656.27	1,421.12	23.33	20.02	24.08
Oregon	1,051	100.20	10,704.57	10,704.57	10.19	10.19	26.46
Pennsylvania	24,480	115.01	984,634.72	425,667.50	40.22	17.39	25.08
Rhode Island	649	97.82	30,968.00	10,449.29	47.72	16.10	30.55
South Carolina	108	76.74	1,921.50	1,921.50	17.79	17.79	24.49
South Dakota	2,606	70.21	34,961.37	34,961.37	13.42	13.42	28.95
Tennessee	15	168.47	665.64	468.27	44.38	31.22	38.19
Texas	143	118.60	3,928.60	3,928.60	27.47	27.47	25.12
Utah	693	81.24	11,986.37	11,986.37	17.30	17.30	27.61
Vermont	3,832	74.02	55,010.12	55,010.12	14.36	14.36	16.43
Virginia	748	89.58	30,996.25	15,697.45	41.44	20.99	17.35
Washington	2,644	129.46	62,857.54	62,857.54	23.77	23.77	26.25
West Virginia	786	79.61	21,690.76	10,610.91	27.60	13.50	20.21
Wisconsin	23,864	115.32	429,999.16	429,999.16	18.02	18.02	32.95
Wyoming	90	53.94	1,640.11	876.54	18.22	9.74	7.80
Total	207,830	97.04	5,693,270.50	3,459,719.10	27.39	16.65	30.69

[1] Salvage paid to State.

ERADICATION OF TUBERCULOSIS FROM SWINE AND FOWLS

Studies incident to the control and eradication of tuberculosis from swine and poultry were continued. Many State agencies devoted considerable time to the question of avian infection, particularly as it pertained to its transmission to swine. A considerable amount of tuberculin testing of poultry was conducted, looking to a study of the possibilities of controlling the disease by test methods. The general conclusions drawn from the work are

as follows: The best method of control is to rely upon the education of the poultry owner as to the need of proper sanitation, maintenance of flocks under the best conditions of poultry husbandry, and the use of the tuberculin test when necessary for the diagnosis of the disease.

Incident to these studies, the bureau made a limited survey of the extent of avian tuberculosis by means of the tuberculin test, the principal purpose being to obtain information on the extent of the disease in States believed to be relatively free. Nine States where the extent of the infection was known to be very heavy were omitted from the study. Of the remaining 39 States 27 reported some tuberculosis in the poultry. These tests included 1,474 flocks, of which 414 were found to be infected. More than 85,000 fowls were tested, resulting in over 9,300 reactors being obtained. Post-mortem examinations were conducted on 272 of these reactors, resulting in macroscopic lesions being demonstrated in 206 cases. Thus of the flocks tested more than 27 per cent were infected. A further study of the survey showed only a very slight incidence of the disease in 22 of the 27 States. One noteworthy result was that in a few States infection was found to exist to a considerably greater extent than was anticipated.

In connection with this study of the extent of avian infection, a questionnaire was sent to several thousand poultry owners through the bureau field offices located in the respective States. More than 3,100 owners replied, 43 States being represented. The purpose of the questionnaire was to ascertain, if possible, under what conditions poultry flocks were being maintained, and the possible connection such maintenance conditions may have had with the transmission of the disease from flock to flock. A general study of all the figures afforded by the survey furnished the following conclusions: (1) That the poultry industry is not fully informed relative to avian tuberculosis and that much more educational work is vitally necessary; (2) that no definite conclusions can be deduced as to the most frequent mode of transmission of avian tuberculosis from flock to flock.

The survey of flocks in connection with the testing of cattle was continued. During the year 211,675 flocks, containing approximately 16,500,000 fowls in 34 States were inspected. Approximately 12,000 of these were found to be infected with tuberculosis, as was evidenced by physical cases found. These inspections were made in the course of the routine testing of cattle by the regularly employed veterinarians. The information disseminated to poultry owners through the medium of these inspections of flocks will prove of considerable value in the final control of the disease.

REGULATION OF INTERSTATE MOVEMENT OF CATTLE

Most of the tuberculin testing of cattle for interstate movement was done by approved veterinary practitioners, of whom more than 9,000 are on the list approved by State and Federal officials. These men tested for interstate shipment 31,624 herds, containing approximately 382,432 cattle, of which 0.6 per cent reacted. The number tested is an increase of 26,596 over those tested in the fiscal year 1926. Bureau inspectors tested at public stockyards 58,526 cattle, of which 991, or 1.7 per cent, reacted. These figures are included in the total testing for the year, reported in Table 16. Permits were issued for the interstate movement of 66,560 known reactors for immediate slaughter.

TUBERCULIN TESTING

Table 19 indicates the relative use of the various methods of tuberculin testing, as reported.

TABLE 19.—*Methods of tuberculin testing during fiscal year 1927*

Test employed	Cattle tested	Reactors found	Percentage reactors
Intradermic alone	7,659,909	185,775	2.4
Subcutaneous alone	3,250	85	2.6
Ophthalmic alone	564	6	1.1
Combination of tests	1,248,118	78,427	6.3
Total	8,911,841	264,293	2.9

Of the cattle reported tested about 21 per cent were tested by bureau inspectors, and about 79 per cent by State, county, municipal, and accredited practicing veterinarians. The usual detailed attention was given to the so-called nonvisible-lesion cases noted on post-mortem examination of slaughtered, reacting cattle. As was customary in the past, a majority of such cases was found to have originated in herds known to have harbored infection.

Efforts were again made to systematize the work, so as to reduce the cost of testing per head. Favorable circumstances resulted in progress in this direction. The standard of professional services rendered by the field employees was excellent.

CONFERENCES AND PUBLICITY ON TUBERCULOSIS ERADICATION

The annual Eastern States conference on tuberculosis was held at Atlantic City, N. J., June 20–22, 1927, and was largely attended by bureau and State officials, practicing veterinarians, livestock owners, representatives of breeders' associations, public-health officials, county agents, and others. Other successful conferences included the third Lake States conference held at Lansing, Mich., June 27–29, 1927, and the Midwestern States tuberculosis conference held at St. Joseph, Mo., May 26 and 27, 1927.

A wide distribution of department literature on tuberculosis continued. Several exhibits were also prepared and distributed for use at county fairs, local meetings, and other places.

DIVISION OF VIRUS-SERUM CONTROL

The administrative and regulatory work under the virus-serum-toxin act of 1913 was continued by the Division of Virus-Serum Control, under the direction of D. I. Skidmore, chief. The work consisted of the issuance of licenses to establishments producing veterinary biologic products intended for sale in interstate commerce, the inspection of such establishments as to sanitary conditions and methods of production, the supervision of the production and the testing of products, and the certification of products for exportation. It also included the issuance of permits for the importation of biologic products from abroad, and their inspection at ports of entry.

WORK AT LICENSED ESTABLISHMENTS

At the close of the year 87 establishments in 60 cities and towns in 20 States were operated under licenses and inspection as compared with 88 at the end of the preceding year. Forty-nine of the establishments were engaged in producing only anti-hog-cholera serum and hog-cholera virus; 32 in producing other biologic products and 6 in producing both classes of products. Among the products were antisera, aggressins, bacterins, vaccines, tuberculin, and mallein. Inspectors of the bureau supervised the production, and testing of anti-hog-cholera serum and hog-cholera virus. They also conducted tests to determine whether these products were preserved properly, and made periodical visits of inspection to establishments producing other products. Cultures of organisms and samples of products were collected for examination on many of these visits.

An average of 88 inspectors was maintained in the field. They examined and admitted into licensed establishments 580,765 hogs and 901 calves. Four hundred and fifty-three hogs were rejected at the time they were offered for admission and 36,330 hogs were rejected after admission because of conditions which made them unsuitable for the production or testing of biologic products. The inspectors supervised 7,338 potency and 5,821 purity tests of anti-hog-cholera serum and 64 and 3,383 tests of hog-cholera virus for virulence and purity, respectively.

Because of the severe outbreak of hog cholera in the fall of 1926, the period for holding pigs used in testing anti-hog-cholera serum was changed from 21 to 15 days on September 25, 1926, and on October 5 to 11 days, in order that serum might be available for use in treating hogs. On October 18 conditions made advisable the removal of the test requirements entirely and from that date until March 1, 1927, serum, which was still being prepared under official supervision, was released without test if otherwise satisfactory, provided it was labeled to show that it had not been tested.

Bureau inspectors collected 231 samples of products produced by licensed establishments or materials used in preparing such products. On examination in the laboratories 183 of these samples were found to be satisfactory and 31 unsatisfactory or contaminated. Results of examinations made of the remaining 17 were not conclusive. Sixty-five strains of organisms intended for use in the preparation of biologic products by licensed establishments were collected and subjected to laboratory examination. Fifty-six of these were found to be satisfactory and nine unsatisfactory or contaminated. The license of one establishment was suspended for 15 days on account of having misbranded certain hog-cholera virus, failure to prepare and test it under bureau supervision, and to maintain detailed records.

OUTPUT OF BIOLOGIC PRODUCTS

The quantity of anti-hog-cholera serum produced by licensed establish-

ments was 1,288,418,911 cubic centimeters, of which 758,154,015 cubic centimeters was ordinary serum and 530,264,896 cubic centimeters clarified serum. The quantity of simultaneous hog-cholera virus produced was 63,937,062 cubic centimeters, while the production of hyperimmunizing virus amounted to 277,884,604 cubic centimeters and inoculating virus 1,119,023 cubic centimeters, making the total quantity of virus 342,940,689 cubic centimeters. The quantity of anti-hog-cholera serum produced was approximately 50 per cent greater than that of any previous fiscal year, while the production of simultaneous virus exceeded that of any other year by about 45 per cent. This increased production was due to the demand for immunization of swine during and following the outbreak of cholera mentioned and the desire of licensed establishments to have sufficient supplies of serum on hand should an emergency again arise.

The production of other biologic products by licensed establishments aggregated 29,720,732 doses, classified as follows: Bacterins, 9,441,856; vaccines and viruses, 6,194,755; aggressins, 8,346,554; tuberculin, 2,993,128; pullorin, 482,510; avian tuberculin, 498,506; mallein, 59,476; antisera and sera, 1,703,947.

PRODUCTS REJECTED

A total of 12,029,426 cubic centimeters of anti-hog-cholera serum was destroyed as unfit for use for the treatment of animals. Of this quantity 8,788,455 cubic centimeters was derived from animals affected with diseases such as tuberculosis, pneumonia, septicemia, etc., and the remaining 3,240,971 cubic centimeters was destroyed because of contamination in the process of manufacture or on account of other conditions which rendered the product unfit for use. The total amount of simultaneous virus destroyed was 1,506,234 cubic centimeters, of which 726,620 cubic centimeters was destroyed on account of being derived from diseased animals and 779,614 cubic centimeters because of contamination and other undesirable conditions. The total quantity of hyperimmunizing virus destroyed was 11,343,626 cubic centimeters, of which 10,249,307 cubic centimeters was destroyed on account of disease and 1,094,319 cubic centimeters on account of contamination and similar conditions.

EXPORTS AND IMPORTS OF BIOLOGIC PRODUCTS

The exportation of biologic products continued to increase. Four hundred and thirty-four certificates were issued to accompany shipments to 27 foreign countries.

At the close of the year permits were outstanding which enabled the importation into the United States of products from two different foreign producers. These permits allowed the importation of anthrax vaccine, antiblackleg serum, blackleg vaccine, blackleg cultural aggressin, blackleg bacterin with a number of other bacterins, polyvalent serum, and tuberculin. The Treasury and Post-Office Departments cooperate with the bureau in preventing the importation of products of a biologic character except in the regular manner and under permit. Bureau inspectors at ports of entry regularly examine all packages of such products before they are released for distribution in this country. A number of products not eligible for importation were either denied entry or destroyed during the year.

ZOOLOGICAL DIVISION

The scientific investigation of animal parasites, and the practical application of control measures along the lines of treatment and prevention were continued under the direction of Maurice C. Hall, chief.

ROUNDWORMS AND OTHER INTERNAL PARASITES OF SHEEP

The work on internal parasites of sheep, which was transferred from Vienna, Va., to McNeill, Miss., in February, 1926, has developed several interesting facts. Investigations in Virginia had shown that with reasonable stocking of pasture with sheep it was possible to control worm parasites by routine dosing at three-week intervals, using such common medicinal agents as copper sulphate solution or a tobacco and copper sulphate solution.

When the sheep were transferred to Mississippi under conditions requiring heavy stocking on pastures of carpet grass, Lespedeza, and crab grass, these measures of control were ineffective and almost 80 per cent of the lamb crop was lost from parasites the first year, and the surviving sheep were very much under normal weight. The animal husbandman at the McNeill station had experienced similar results and had finally transferred his sheep

to a large piney woods area, stocking it very lightly. Under these conditions the flock has shown an increase for the first time.

The Zoological Division is now trying more drastic control measures for worm parasites in sheep under conditions of relatively heavy stocking at McNeill with the hope of developing an adequate method of control. At present it appears that heavy stocking under conditions prevailing in many parts of the South will prove to be a losing proposition in the absence of suitable control measures which have yet to be developed. Since very light stocking does not give promise of being a profitable enterprise, the need for such control measures is evident.

ROUNDWORMS AND OTHER INTERNAL PARASITES OF SWINE

The project on control of roundworms and other parasites of swine was transferred from McLean County, Ill., where it had been highly successful, to Moultrie, in Colquitt County, Ga. The work was begun there in May, 1926. A preliminary survey showed that pigs were generally farrowed in open hog lots or in wooded pastures, usually low-lying pieces of land with shade and small streams to provide water. Little attention was paid to the pigs at farrowing time, and the pigs were counted when the sows brought them up to the hog lots in which they were given a little feed. The pigs were usually marketed when from 12 to 14 months old. The animals are carried largely under free-range conditions, and many hog raisers figure that it costs nothing to carry animals on range or in old woodland pastures until the fall crops are ready for the hogs. The use in the South of the swine-sanitation system, developed under Middle West farming conditions, called for a considerable change in the system. As developed, the system required that the sows and litters be placed on the best part of the land under fence and held there on a suitable green grazing crop to protect the animals from worm infestation.

In 1926, nine farmers in Georgia cooperated in the experiment. Pigs on these farms were usually marketed at from 10 to 18 months, and animals varied in condition from very poor to very good. The hog lots showed a range in condition from very insanitary to very good, but in general the hog lots in the sandy areas around Moultrie are much cleaner than hog lots in the heavy-clay regions of the Middle West and are usually exceptionally free from unpleasant odors. All the cooperators thought that worms were largely responsible for the unthrifty condition observed among their pigs. Laboratory examinations supported this opinion, showing several species of worm parasites present, including such important forms as the large roundworm or ascarid (*Ascaris suum*), kidney worm (*Stephanurus dentatus*), the small red stomach worm (*Hyostrongylus rubidus*), and lungworms (Metastrongylus spp.), the first named being the most prevalent.

The first use of the sanitation system on these farms was begun with the fall farrow of 1926. Farrowing commenced July 12, and ended December 28, the farrowing period on the different farms being spread over periods of from three weeks to four months, a very unsatisfactory system of breeding animals. On these farms 46 sows were placed on "clean" ground. They farrowed 330 pigs, of which 74 were lost at farrowing time, 12 lost on pasture, and 244 saved. Of those saved 102 were marketed and 34 sold for breeding and feeding. There were only 3 actual runts among the pigs, but the condition of the animals varied with the feed, as would be expected, and ranged from poor to excellent. The weather was very dry and the grazing poor as a result.

The average number of pigs farrowed per sow was 7.17; the average number saved was 5.3. Losses from all causes amounted to 26.06 per cent of pigs farrowed.

Laboratory examinations of these pigs showed the presence of various worms, with the large roundworms most prevalent. The degree of infestation may be judged from a detailed and careful post-mortem examination of 19 of the pigs. This showed 101 ascarids (average of 5.31 worms each), 85 lungworms (average of 4.47 each), 62 whipworms (average of 3.26 each), 53 strongyline stomach worms, *Arduenna strongylina* (average of 2.58 each), 7 small red stomach worms, 5 nodular worms, 3 thorn-headed worms, and 2 kidney worms. All but two of the livers were normal.

Three herds, totaling 150 hogs, were carried as checks on this experiment. The average litter farrowed was 6.06 pigs, of which an average of 4.25 were saved. Laboratory examinations showed a number of worms present in these pigs, ascarids being most com-

mon. Various species of worms were found post-mortem, lungworms being most common.

A consideration of these data indicate that the first tentative test of the swine-sanitation system in the South promises an efficiency comparable to that attained by it in the Middle West. The saving of 5.3 pigs from each litter of 7.17, approximately 74 per cent, shows a slight gain over the reported saving of 4.25 out of each litter of 6.06 pigs in the check lot, or 70 per cent, both figures being above the estimated average of 50 to 55 per cent saved in customary practice. It may be added that ranging animals over a wide area of free range is itself an application of one of the preventive or control measures for parasites. The gain is more evident on a consideration of the pigs marketed. The 68 sanitation pigs marketed averaged 195 pounds, whereas the 27 check pigs averaged 193.25 pounds, a very slight difference, but the former were from about 5 to 9 months old, whereas the latter were from 6.5 to 11 months old, a difference of 6 to 8 weeks' feed saved as judged by the extremes of the ages given. The condemnation of 19 out of 27 livers, almost 70 per cent, in the check herds, as compared to 2 out of 19, or 10.5 per cent in the sanitation herds, is important evidence. There is a heavy condemnation of livers and other parts of swine in the South as a result of parasites, and reduced losses may be expected to result from the use of the sanitation system. The fact that the sanitation system apparently kept the numbers of worms in pigs to an average of not over 5.31 per pig for the most prevalent kind indicates that it is effective for the purpose for which it was intended and will serve this purpose in the South as well as in the Middle West.

In the spring of 1927, 20 farmers cooperated. On their farms 117 sows farrowed. The average litter was 7.27, of which 6.05 were saved, or 83.2 per cent. Five check herds, having use of a wide range, totaled 24 sows, which farrowed 166 pigs and saved 152, or 91.56 per cent; the average litter was 6.91 pigs, of which 6.33 were saved. The results here indicate that wide range may have the same effect, as would be supposed, in controlling worm infestation that the swine-sanitation system has, and may be adapted to southern conditions to advantage. However, all findings in check herds must be regarded as uncertain and the indicated results probably better than the facts actually warrant.

One promising result is the finding of only 1 kidney worm in each of 2 sanitation pigs out of 926 slaughtered, in spite of heavy infestations in sows.

As a check on the farm experiments, arrangements were made, effective in February, 1927, to have all the pigs on one farm handled under the direct supervision of the men in charge of this experiment. On this farm 8 sows farrowed 64 pigs in 1927, with the following additional results: Lost 16, saved 48; average pigs per litter, 8; average saved, 6, or 75 per cent. In this experiment the pigs were fed peavine, peanut, and crab-grass hay, the first time hay has been fed to pigs in this section of the country.

The scientific and practical results of the previous work in McLean County, Ill., were prepared for publication during the year. In the usual farm practice approximately half, or a little more, of the pigs littered are actually sent to market, held for breeding stock, or otherwise brought to profitable maturity. The data from the McLean County experiment show that the use of the swine-sanitation system cuts the usual loss approximately in two and is almost 100 per cent effective in preventing the losses the system was designed to prevent. The residual loss occurring where the system is used results primarily from such factors as poor breeding, poor feeding, poor judgment resulting in accidents and similar losses, losses from hog cholera, and other losses not entirely preventable by sanitation alone. The prevention of these residual losses will require the efforts and cooperation of the farmer, the animal husbandman, and the veterinarian. These results were given a special form of publicity through a "swine sanitation special," a train carrying exhibits and specimens, and making, usually, two stops a day at various towns in Ohio. This train was arranged for by cooperation of departmental, State, and railroad agencies.

A continuation of studies on the viability of ascarid eggs in soil under prevailing outdoor weather conditions in Illinois indicates that eggs may remain alive for 10 to 12 months or may all perish in the course of 5 to 6 months from spring to fall. Eggs passed on the pasture in the fall (October) may be viable, but not yet developed to the infective stage, by the 1st of June the following year.

A cooperative study with the Pathological Division developed the fact that parasitic nodules due to lungworms in swine may be easily differentiated from tubercular nodules by a simple press preparation method, and that these nodules are due to *Metastrongylus elongatus* and possibly to *Choerostrongylus pudendotectus* also.

PARASITES OF CATTLE

A project for the investigation of cattle parasites was undertaken at Jeanerette, La. The first line of investigation has been in the nature of a survey to ascertain just what parasites are present and how prevalent and important they may be. To that end post-mortem examinations have been made of cattle at various abattoirs and the findings compiled statistically. The work is also being extended by fecal examinations. It is still too early to draw conclusions regarding these parasites.

CONTROL OF EXTERNAL PARASITES

During the previous fiscal year reports received from packers indicated that considerable loss to hides resulted from injuries caused by demodectic mange. In spite of the fact that hide damage showed demodectic mange to be rather common and widespread in the United States, the disease had been reported in only a few cases. Directions for examining cattle for demodectic mange were sent to the field forces of the bureau and as a result of their cooperation the wide occurrence and distribution to be expected from a knowledge of hide conditions was found. Cases were found in live cattle originating in 14 States, including Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Missouri, New Mexico, Nebraska, Nevada, Ohio, Oklahoma, Texas, and Wisconsin. Numerous cases also were detected post-mortem. The field forces now are becoming more adept in detecting the condition and there has been a distinct advance in knowledge of the extent of demodectic mange. A small number of cattle in different stages of the disease have been collected and put into experiments to determine, if possible, some effective control measure for the disease.

While the inspection for demodectic mange in cattle was under way, the field forces of the bureau were asked to report cases of demodectic mange in swine. Up to the end of the fiscal year about 1,400 such cases had been reported from post-mortem inspections in the following States: Colorado, Georgia, Illinois, Indiana, Iowa, Kansas, Minnesota, Nebraska, Ohio, Texas, Virginia, and Washington. Evidently demodectic mange in cattle and hogs is widespread and is undoubtedly of considerable economic importance.

Studies on sheep scabies show that most cases of the disease are apparently contracted by direct contact with infected animals, and that corrals and small inclosures which have been occupied by infested sheep are not a source of danger to clean sheep for a period longer than 30 days. In connection with this study a bulletin on sheep scab was revised and the recent findings included.

Studies on sheep and goat lice indicate that these parasites are usually spread by contact with infested animals, and that the lice can be eradicated by dipping infested animals twice, with an interval of 14 to 16 days between dippings. The most effective dips are the arsenical solutions, coal-tar-creosote dips, and the tobacco or nicotine dips. A manuscript on sheep and goat lice was prepared for publication as a department leaflet.

Experimental work on ox warbles in farm and range cattle was continued. Wading tanks were used to apply solutions to the lower parts of the legs of cattle, using coal-tar creosote on range cattle and petroleum on farm cattle. The results indicate that this procedure is not very effective in reducing ox-warble infestation, as it apparently causes the fly to deposit her eggs above the treated areas.

TESTS OF ANTHELMINTICS

In view of reiterated claims made in various publications in opposition to the position of the zoological laboratory that chenopodium is more effective than santonin for the removal of roundworms, when the drugs are administered in one therapeutic dose, the experimental work of the laboratory with santonin was repeated. The results confirmed the previous position and indicate that santonin is overrated in some of the claims that are being made in regard to it.

An investigation outside of the department threw additional light on the subject of carbon tetrachloride, proposed by this bureau as an anthelmintic. The work in question indicates that some of the bad results occasionally experienced are probably due to a calcium deficiency in the blood, and that a high calcium intake before treatment will probably prevent untoward results from this cause.

Tetrachlorethylene, a drug proposed for the treatment of hookworm disease in man and animals by the bureau in 1925, has had additional use in human and veterinary medicine and still gives promise of being better in some respects than the drugs previously used. It is rapidly taking the preferred place for this purpose in treating dogs and foxes. Tests of this drug were made on foxes in cooperation with the Bureau of Biological Survey and gave excellent results.

Miscellaneous studies included tests of gastrointestinal lavage with water at relatively high temperatures, and of mercurochrome, leche de higueron, and various other substances for the removal of worm parasites. The kamala treatment for tapeworms in birds, proposed the previous year, has since come into very general use.

PARASITIC FLATWORMS

Studies on flukes during the year include the following: Attempts to ascertain the snail hosts of the common liver fluke of sheep and cattle, in the United States; a synoptical study of the blood flukes, with a study of some new species and the description of new genera; a study of a fluke representing a new genus collected from the gall bladder of a spider monkey; the collection and study of a number of flukes from the dog and other carnivores; and a comparative study of the salmon-poisoning fluke from the dog, coyote, lynx, and raccoon

Some larval tapeworms of the genus Tetrathyridium were obtained from a mongoose on post-mortem examination, and these tapeworms were reared to fertile maturity in dogs and cats, the adults being found to belong to the genus Mesocestoides, a group of tapeworms of which the life histories were unknown and which are of importance as parasites of dogs and cats. Two months after a preliminary paper on these findings was sent to press, a paper published in one of the French veterinary journals came to hand containing somewhat similar findings, the two investigations confirming the correctness of each other's results.

PARASITIC NEMATODES

In connection with the study of the life history of the kidney worm, a study of its pathological effects has been undertaken. Although it is too early to advance definite conclusions at this time, the study indicates that the so-called "parasitic livers" of swine are due to some extent and in many cases to kidney worms as a result of the migrations and development of the larval worms in the liver. Following experimental infections with larvae, the livers of the pigs in the experiments show fibrosis, passive congestion, eosinophilia, and pressure atrophy of the liver lobules.

A continuation of the study of nematode parasites of poultry and other economically important birds has brought to light some additional pathogenic worms, some of them new to science. A number of worms, new or at least not previously known in North America, are now known to cause death in chickens, turkeys, domestic and wild geese, pigeons, and certain wild birds. Among these worms are a new species of Echinuria, markedly pathogenic for geese, and a new gapeworm, the cause of numerous fatalities among geese. In connection with this work the division has cooperated with the Bureau of Biological Survey in a study of quail parasites and with various organizations in the investigation of losses among New England ruffed grouse. A monograph on bird nematodes, exclusive of filarids and trichurids, appeared late in the year, and the study of the filarids and trichurids was begun.

The pathogenic nematode, *Capillaria annulata*, previously reported as the cause of deaths among chickens and turkeys, has been found in additional outbreaks of parasitic ingluvitis, and has been further studied; the eggs were found to develop to the infective stage in three months. A survey of parasites of chickens and other birds in Georgia and Mississippi disclosed the presence of some pathogenic forms and some new species and hosts. A systematic card catalogue of bird nematodes has been compiled as a separate section of the index catalogue, and a very comprehensive set of illustrations of known bird nematodes has been made.

MISCELLANEOUS INVESTIGATIONS

A survey of the parasites of livestock of Central America was made in Panama, Nicaragua, and Salvador. The findings indicate that there is comparatively little danger of the importation of economically important internal parasites from these countries. The range livestock was surprisingly free from internal parasites, apparently because of the occurrence of a prolonged dry season with no precipi-

tation alternating with a season of torrential rains. Household animals showed parasitic infestations comparable to those in parts of the United States.

A study of the parasites of wild carnivores made possible by the cooperation of the Bureau of Biological Survey was continued, and many of the species determined. This study supplements post-mortem examinations of animals dying at the National Zoological Park, including a number brought by the Smithsonian-Chrysler expedition to the park. It is increasingly evident that a number of parasites are transmissible from wild to domesticated animals, a matter of great economic importance.

The work on the longevity of worm eggs and larvae in manure piles and the study of methods for their destruction was continued, and certain substances were found to be promising as destroyers of these organisms without being deleterious to the fertilizer value of the manure.

A survey of parasites in North America, heretofore carried on in a casual way owing to lack of adequate personnel, was undertaken as a special detail with a view to ascertaining rather definitely the distribution and importance of various parasites as a basis for the selection of the more important problems in the field of parasitology in the United States. This study is being based on the collections and correspondence of the bureau, the published literature, and by means of a questionnaire, and considerable progress has been made in the work, largely through the interest and cooperation of parasitologists, zoologists, veterinarians, physicians, animal husbandmen, and others.

A new number of the index-catalogue, one covering the Crustacea and Arachnida of importance in human parasitology, was published in collaboration with the Public Health Service.

Approximately 1,000 accessions of parasites were added to the collections. Numerous post-mortem examinations were made, including about 100 animals from the National Zoological Park. The collection of illustrations of parasites has been increased to approximately 7,000 drawings, systematically arranged, supplemented by approximately 1,850 photographic negatives and 340 lantern slides.

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BUREAU OF BIOLOGICAL SURVEY

REPORT FOR 1927

copies could not be obtained

JAN 4 1928

REPORT OF THE CHIEF OF THE BUREAU OF CHEMISTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., June 30, 1927.

SIR: I beg to submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1927.

Respectfully,

C. A. BROWNE, *Chief.*

Hon. W. M. JARDINE,
Secretary of Agriculture.

INTRODUCTION

The present report of the Chief of the Bureau of Chemistry is the last to be submitted for this bureau as an independent departmental organization. It is therefore appropriate at this time to make some reference to the early development of the chemical work of the department and to the indications for future progress in this field.

In the act of Congress for 1862 for establishing a Department of Agriculture, it was enacted, in section 4, "That the Commissioner of Agriculture," in addition to the appointment of a chief clerk and other employees, "shall, as Congress may from time to time provide, employ other persons, for such time as their services may be needed, including chemists, botanists, entomologists, and other persons skilled in the natural sciences pertaining to agriculture."

In the first report of the Commissioner of Agriculture to President Lincoln, Isaac Newton called attention to the importance of chemistry to agriculture. As a basis for this opinion he referred in the following words to the action of the Board of Agriculture of Great Britain, appointed by Prime Minister Pitt in 1793: "More than all, the board was instrumental in employing Sir Humphrey Davy to make those experiments which are not only an honor to intellect, but which established agricultural chemistry as a department of science and of inestimable value."

In accordance with his view of the primary importance of chemistry to agriculture, Commissioner Newton appointed as the first scientific employee of the newly created department the distinguished chemist Charles M. Wetherill, already well known for his investigations upon the chemistry of agricultural products. Doctor Wetherill's report as chemist of the department for January 1, 1863 (Department Report, 1863, pp. 508–540), the first and only scientific report to be submitted during the first year of the department's activities, marks the inception of chemical research in the department. It describes investigations along several important lines, such as the composition of American grapes, a chemical study of sorghum, sorghum sirup and sorghum sugar, and analyses of sugar-cane products. After Doctor Wetherill's resignation in 1863 chemical investigations were initiated by his successor, Henry Erni, upon soils, fertilizers, sugar beets, and fermentation. Thomas Antisell, who became chemist of the department in 1866, started investigations upon marls, greensands, and phosphates in 1867, upon tanning materials and sweet potatoes in 1868, and upon peanuts, meat extracts, and foods in 1869. In his report for 1869 Doctor Antisell called attention to the extensive adulteration of fertilizers and feedstuffs and to the need of controlling the purity of these products by chemical supervision. The future chemical regulatory activities of the department

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are here foreshadowed for the first time. It is seen that, notwithstanding the serious distractions of the Civil War period and the very limited provisions for scientific research, a broad foundation was laid before 1870 along many lines for the future chemical work of the department.

After Doctor Antisell's resignation, chemical investigations were begun by Ryland T. Brown in 1871 upon cassina and in 1872 upon the agricultural value of sewage. William McMurtrie, the next chemist of the department, initiated investigations upon cereals in 1873, upon insecticides in 1874, upon sugar corn in 1875, upon bat guano in 1876, and upon the chemistry of mildew and rot in 1877. Peter Collier, chemist of the department from 1878 to 1883, in addition to various items previously mentioned, made chemical examinations of waters, baking powders, tea and coffee substitutes, butter and oleomargarine, veterinary medicines, grasses, and numerous other products employed or produced by agriculture. Doctor Collier made also extensive investigations upon the production of sirup and sugar from corn and sorghum. His work upon sorghum is the most extensive chemical investigation of this crop which has ever been performed.

In 1883 Doctor Wiley was appointed chemist of the department, and the impress which he gave to the chemical work of the Department of Agriculture and to agricultural chemistry, during the 29 years of his Governmental service, has been of a lasting character. The chemistry division of the department, when Doctor Wiley assumed its direction, was located in two small rooms in the basement of the old agricultural building and had a personnel of only 3, which number had expanded at the time of his resignation in 1912 to over 500.

In 1883 the first bulletin of the chemical division of the Department of Agriculture was issued. This related to the composition of American wheat and corn and was the precursor of a long series of bulletins dealing with the chemistry and technology of American food products. The best known of this series was the important Bulletin 13 upon foods and food adulterants, of 1,417 pages, dealing with the chemical composition, technology, and adulteration of dairy products, spices, fermented beverages, lard, baking powders, sugar, molasses, confections, honey, tea, coffee, cocoa, canned vegetables, cereals, and preserved meats. The publication of the 10 parts of Bulletin 13 extended over a period of 15 years, from 1887 to 1902. The wide attention called to the practice of food adulteration by the various parts of this bulletin was an important factor in the movement which led to the final passage of the Federal food and drugs act in 1906.

The division of chemistry was created a bureau of the department in 1901 and it was to the Bureau of Chemistry that Congress assigned the execution of the Federal food and drugs act. These new regulatory activities, which were a direct consequence of long, extensive research, led to the establishment of numerous branch laboratories of the Bureau of Chemistry, in different cities of the United States. The regulatory work of the bureau was still further enlarged by its being intrusted in part with the execution of the Federal insecticide act of 1910, which was also a result of the previous research work of the bureau upon the chemical composition and adulteration of insecticides, germicides, and fungicides.

Coincident with these investigations upon foods, insecticides, etc., the Division, and afterwards the Bureau, of Chemistry performed a large amount of work in collaboration with the Association of Official Agricultural Chemists upon the improvement of methods for the chemical analysis of agricultural products. The results of this work are contained in the Proceedings of the Association of Official Agricultural Chemists (the first 29 volumes of which were published as bulletins of the Division, or Bureau, of Chemistry) and in numerous bulletins upon methods of analysis. The contacts between the chemists of the department and of the various State institutions secured by the meetings of the Association of Official Agricultural Chemists have been of the greatest value in promoting the advancement of agricultural chemistry along both research and regulatory lines.

The chemistry division of the Department of Agriculture was not only the first Federal agency to investigate the chemistry and technology of soils, fertilizers, cattle feeds, insecticides, and the various food products derived from cereals, sugar crops, fruits, vegetables, meats, fish, poultry, and milk, but it was the earliest to make chemical studies upon forestry products, naval stores, paper, leather, tanning materials, dyestuffs, paints, varnishes, denatured alcohol, and many

other materials of industrial importance. The department's division of chemistry, as originally conceived and developed, was the agency in which all the chemical work of the Government should be performed, but with the rapid expansion of scientific work in other bureaus of the various Federal departments this plan became too extensive for practical continuance. The relation of chemistry to agriculture and industry in both America and Europe had been gradually changing from that of an independent to that of a cooperating science. As stated in my report for 1924, "An increasing need for chemists was felt in every branch of governmental service, with the result that chemical work on contract supplies, soils, road materials, forestry products, dairy products, meat products, and other commodities, which had been initiated by the Bureau of Chemistry was gradually taken over by Federal agencies that were specifically charged with the investigation of these materials."

Coincident with this general realignment of chemical activities in Federal and State institutions, another movement had been slowly gathering headway—the complete separation of research and regulatory work. These two lines of activity were recognized in European countries to be so different in purpose and method that their complete segregation under different administrative offices, with different laboratories and personnel, was effected a half century ago. Research and regulatory work demand the attention of officials of entirely different qualifications. The regulatory chemist, because of the detriment of delayed decisions to industry and commerce, is obliged to form his conclusions quickly, although in some cases these decisions may be wrong. The research chemist, on the other hand, must form his conclusions with more deliberation because of the necessity of verifying his work by all the possible checks at his disposal. The regulatory chemist, owing to the demands of law enforcement, limits his attention to the small percentage of products which constitute infractions of certain State or Federal enactments and ignores the vastly larger percentage of products which meet the requirements of those acts. The research chemist, on the other hand, is concerned more with the rendering of service to industries whose products are of the latter class.

On account of the interferences of the regulatory work with the research activities of the agricultural experiment stations, many of the latter have either transferred all their law-enforcement work to State officials or have established independent laboratories, where the two lines of work can be conducted with less interference. A few experiment-station directors, however, are still of the opinion that some connection of the station with regulatory work upon fertilizers, cattle feeds, human foods, insecticides, etc., is advisable, not only for the benefit of the agricultural contacts, but because of the unfortunate degeneration of the regulatory work in some States where it has lost contact with research and scientific control.

The movement of separating the chemical research and regulatory work of the Bureau of Chemistry was longer deferred than elsewhere on account of the extremely close connection which has existed between these two branches of the service, and perhaps also because of the recognized efficiency with which each line of work was directed. Previous to 1906, when the Federal food and drugs act was passed, the work of the Bureau of Chemistry was exclusively along research lines, and it was upon the basis of such research that chemical methods were developed for the detection of adulteration, that the prevalence of sophistication in foods, drugs, insecticides, and naval stores was ascertained, and that laws were finally passed for correcting these abuses. After the passage of the various regulatory acts that were entrusted to the Bureau of Chemistry for execution, parallel lines of research and law-enforcement work were initiated that have been in many ways mutually beneficial. Chemical research has enabled the regulatory branch of the service to assist manufacturers in meeting the requirements of law enforcement; the regulatory service, on the other hand, has assisted chemical research by its suggestion of urgent practical problems, with the avoidance of lines of investigation that were too academic or visionary. It is hoped that with the separation of the research and regulatory activities of the Bureau of Chemistry under separate administrative offices the advantages of the old system of close collaboration between the chemists engaged in these two lines of work may so far as possible be maintained.

It can not be denied that with the enormous extension of the regulatory work of the Bureau of Chemistry since 1906 in the enforcement of the Federal food and drugs act, the insecticide act, the tea inspection act, and the

naval stores act, the expansion of its former research activities has greatly suffered. This has been due to the inability to obtain proper financial support for much-needed investigations in competition with the very urgent need of funds for the inspection and police work. The amount of the appropriations expended by the Bureau of Chemistry for regulatory work during the last fiscal year was $1,111,385, while that expended for research was only $380,221. The only possible inference to be drawn from these figures is that the quantity (but not the quality) of the research work of the Bureau of Chemistry has been overshadowed by the development of its regulatory operations.

The chemical researches of the Bureau of Chemistry upon the utilization of agricultural wastes; upon the prevention of losses of agricultural products from deterioration and from the effects of fires and other destructive agencies; upon improvements in the chemical technology of foods and other agricultural products; upon the development of better methods of agricultural chemical analysis; and upon fundamental investigations concerning the carbohydrates, proteins, fats, waxes, essential oils, tannins, glucosides, organic acids, and other constituents of agricultural products, should be greatly amplified and extended. It is hoped that these research activities of the former Bureau of Chemistry, which form the branch of "chemical and technological research" in the newly constituted Bureau of Chemistry and Soils, may undergo a new period of enlargement and growth commensurate with the importance of such investigations to agricultural science and with a continuance of the same spirit and aims which have made the name of the Bureau of Chemistry universally known for its long splendid record of service and accomplishment.

RESEARCH

In line with the purpose for which the Bureau of Chemistry was created, research in agricultural chemistry was continued during the fiscal year, with the following outstanding results.

CROP CHEMISTRY

Research was directed toward the improvement in quality of wheat and rye, special attention being given to the relation of the spacing of rows to yield and composition of grain. The influence of soil acidity on the yield and composition of lettuce and other green vegetables was also studied. The principles governing absorption by plants of potassium and phosphorus were investigated by growing seedlings in solutions of compounds of these elements.

Studies were made of the chemical changes in tomato seedlings during their growth, with transplanting, in the greenhouse before transfer to the field. Some of the plants were set out in tiles which had been buried in the ground and filled with soil of different reactions from the fields at Welcome, Md., where a similar study was conducted two years ago, in order to find out whether or not the influence of soil reaction on growth would be the same under different surroundings.

An electrical-measuring equipment has been installed to facilitate the determination of soil reaction, formerly done colorimetrically only. Extensive trials of the quinhydrone-electrode method of making these determinations have given results that agree with those obtained by the colorimetric method. Henceforth these two methods will be used in parallel.

FRUIT AND VEGETABLE CHEMISTRY

Since its establishment in 1913, the laboratory at Los Angeles, Calif., has worked out methods for the utilization of cull and surplus fruits, for the detection and elimination of frosted citrus fruit, and for the determination of maturity of citrus fruits, cantaloupes, and pomegranates. It has also aided materially in establishing standard grades for raisins.

BY-PRODUCTS

During the last year, a device for the mechanical production of lemon oil was developed, and studies on the composition of California citrus oils were continued. The by-product work has included also the production of pomegranate juice and jelly and has been extended to include problems in the bottling and canning of cider. As a result of this work, both pomegranate juice and jelly are on the California market and bid fair to become standard products throughout the country.

MATURITY STANDARD

A maturity standard for pomegranates was developed and submitted to the Pomegranate Growers Association,

with the result that it is now a part of the California standardization law. This standard limits the acidity to 1.85 per cent of anhydrous citric acid and the color of the juice as equal to or exceeding 20 red+1 yellow on the Lovibond scale.

FROSTED FRUIT

Opportunity for further work on the problem of setting satisfactory standards for the control of the shipment of frosted fruit was afforded by the disastrous freeze in Florida last January. A branch laboratory was established at Orlando and many of the methods which had previously been developed were tested under Florida conditions. Among the most satisfactory tests that have been developed for keeping frozen fruit from the market is one depending upon the volume of juice yielded by partially damaged oranges.

COLORING FRUIT

Prior to 1923 work was done on the problem of coloring mature oranges and lemons. In that year a method using ethylene was perfected and patented. Because of the importance of the effect of this process on the composition of fruit and vegetables data were accumulated, which indicated that the process brought about little or no change in the edible portion of the fruit. Since that time the coloring effect of ethylene has been tried on other products, including avocados, bananas, dates, persimmons, and tomatoes. Although the data are meager, they do not indicate a material change in composition except in persimmons, the tannin in which seems to be rendered insoluble or decomposed.

The method for coloring citrus fruit by means of ethylene has been generally adopted in California and Florida. The process requires a temperature of from 65° to 80° F., so that during the winter months it is often necessary to raise the temperature of the fruit. This is usually done by kerosene stoves, the combustion gases of which are themselves coloring agents, which makes the use of ethylene unnecessary. However, in many places the stoves are used only to raise the temperature, and they are extinguished at night. Using ethylene instead of stoves at night eliminates the fire risk of a kerosene stove and the need for a watchman. Studies of the application of the process to coloring other fruits and vegetables are being continued.

INHERITANCE THROUGH VEGETATIVE PROPAGATION

The inheritance of composition from one generation of fruit to the next through vegetative propagation is being further studied. The data on the variants of the Washington navel orange are being compiled and the report is in course of publication. The investigations are being continued with the Eureka and Lisbon lemons. Some work has also been done on the composition of the California loquat.

COMPOSITION OF COTTON PLANT

In collaboration with the Bureau of Plant Industry, a study of the composition of the leaves of the cotton plant has been undertaken to discover, if possible, the reason for thrips attacks on cotton plants that have been insufficiently irrigated.

SULPHURED FRUIT

In cooperation with the Dried Fruit Association of California, an attempt is being made to reduce the quantity of sulphur dioxide remaining in dried apricots, peaches, and pears. It is hoped, as a result of these investigations, not only to reduce greatly the quantity of sulphur dioxide used to preserve the fruit, but possibly to eliminate its use entirely. Preliminary studies indicate that the combination of sulphur dioxide with the constituents of the fruit is unstable, especially the combinations with the coloring matter. The effects of heat, of pressure, and of vacuum on the sulphur-dioxide fixation have been studied. It is hoped that the foundations have been laid for materially changing the details of the process. Already it has been found that inactivation of the peroxidase of the fruit is correlated more closely with heat than with sulphur treatment. Bromine, chlorine, nitric oxide, and carbon dioxide impregnations have not been found suitable substitutes for sulphur dioxide.

PICKLES

For many years the bureau has conducted investigations, with a view to improving methods of converting vegetables into pickles.

During the last year the effect of certain salts that occur in natural waters on the fermentation and curing of cucumbers was determined. Brines containing calcium sulphate, calcium carbonate, magnesium chloride, cal-

cium chloride, ferrous sulphate, and sodium nitrate all had an unfavorable effect, calcium sulphate and calcium carbonate apparently having the least unfavorable influence. Calcium chloride materially retarded the curing process and sodium nitrate made the pickles unfit for use. The iron salt, even when present in comparatively small proportions, had a darkening effect. These experiments showed that (1) the less salt, other than sodium chloride, a brine contains, the better the pickles will be, (2) under experimental conditions at least 60 days are required for the thorough curing of cucumbers, and (3) under experimental conditions a 40° brine will not prevent for very long the spoilage of pickles held at temperatures as high as 25° to 30° C. (77° to 86° F.).

The flavor of dill pickles to which only dill weed had been added was superior to that of pickles to which mixed spices and vinegar, as well as dill, had been added. Apparently, however, the vinegar, by increasing the acidity, aided in preserving the product. In one experimental lot, to which nothing but 2 per cent of cerulose was added, a yeast fermentation rather than a lactic fermentation was soon evident.

SAUERKRAUT

The control of the organisms involved in the preparation of sauerkraut was studied. The results have been incorporated in a manuscript to be published as a technical bulletin of the department.

PRODUCTION OF ORGANIC CHEMICALS BY FERMENTATION

A series of experiments with about 175 varieties of molds resulted in the discovery of one strain which, when grown on solutions of glucose, will produce only gluconic acid. Gluconic acid has been in the past one of the rarer chemicals and it is hoped that, following the development of a method for its production at a price which will allow it to compete with citric, tartaric, and other organic acids, some industrial use may be found for it. It has been suggested that it may be used as a beverage acid or may possibly replace lactic acid in the plumping of hides and the dyeing of silks. The investigation on this process has taken the form of determining the optimum conditions for the fermentation of glucose, and yields of gluconic acid as high as 70 per cent of theory have been obtained. This subject is of great theoretical as well as practical interest, as it is believed that the production of organic chemicals by the fermenting action of molds will be one of the great industrial developments of the next few years. Figures obtained in this investigation may possibly serve as signposts for future work in this field.

FARM AND INDUSTRIAL WASTE UTILIZATION

At the experimental plant erected at Arlington, Va., in 1920, for the purpose of solving basic problems of the dye industry, and of conducting other technological researches, various methods of utilizing farm and industrial wastes have been tried out during the last few years. The outstanding results in this field for the fiscal year just ended are the development of a new metal cleaner and a new paint thinner from industrial wastes and progress in discovering some means of utilizing certain farm wastes.

INDUSTRIAL WASTES

p-Cymene, a waste by-product in the manufacture of paper pulp, the production of which is estimated at more than a million gallons annually, has proved to be a good thinner for paints, varnishes, and lacquers, and also to lend itself to the preparation of a black resinous compound insoluble in acid, alkali, and alcohol, having excellent insulating properties. o-Dichlorobenzene, a by-product in the manufacture of chlorobenzene, was shown to be an excellent cleanser for metals. A study of the formation of 2–3 dichloro-anthraquinone by the condensation of o-dichlorobenzene and phthalic anhydride by means of the Friedel-Kraft synthesis has been carried out on a semiplant scale, and certain optimum conditions for this reaction determined. This work has not yet been completed; methods for the purification of the 2–3 dichloro-anthraquinone prior to its further utilization are still being investigated.

FARM WASTES

The chemical problem involved in the utilization of short-fiber cellulose is in general the same for all farm wastes. In an effort to work out a solution with a distinct bearing on all such wastes, peanut hulls, which are easily obtained from factories where the kernels are utilized, were selected.

A series of experiments have produced a cellulose pulp which promises well as a raw material for rayon, except that it is high in ash. Efforts to reduce the ash content have resulted in the degradation of the alpha cellulose. The problem then is to discover some method of removing ash that will have no bad effect on the alpha-cellulose content of the pulp. An attempt is now under way to extract the soluble materials in peanut shells, determine their composition, and work out some fermentation method for transforming them into a useful substance.

LIGNIN

The investigations initiated by the bureau in 1920 upon the utilization of corncobs and other agricultural wastes for the production of the chemical furfural are now being applied commercially, and the bureau is studying the technical utilization of corncobs, cornstalks, straw, and other agricultural wastes in other ways. An important constituent of these products, now almost entirely wasted, is lignin, which makes up from 20 to 30 per cent of the dry material. The bureau has succeeded in converting lignin into varnishes, dyestuffs, and various aromatic chemicals that give great promise of commercial utilization. Lignin may be called the greatest of all unutilized agricultural wastes and it occupies with respect to industrial possibilities the position held by coal tar a century ago. An article upon lignin from corncobs (Jour. Amer. Chem. Soc. 49, 2037) has been published, and other contributions upon the subject are in course of preparation.

GOSSYPOL

A research fellowship, established by the Interstate Cottonseed Crushers Association, is devoted to an investigation which is being conducted in the laboratories of the bureau upon gossypol—a poisonous phenolic constituent of cottonseed. The presence of gossypol in cottonseed meal has resulted occasionally in the death of farm animals which have ingested too large a quantity of this substance. The results thus far obtained under this fellowship have thrown new light upon the chemical constitution of gossypol. When this phase of the problem has been solved experiments will be made upon the application of the information to the detoxification of cottonseed products.

FOOD AND TECHNICAL MICROBIOLOGY

Work on the monograph on the fungus genus Penicillium is in progress. The discussion of the genus, preparation of species descriptions for known forms and also for forms recognized only in the literature, the bibliography, and special line illustrations have been completed.

Physicians from New York to Georgia and west to Nebraska have been assisted in cases where human disease due to fungi was suspected. The first catalogue of the American Type Culture Collection (for 1927) indicates the successful maintenance of about 200 viable cultures of fungi which are now accessible to universities, physicians, and plant pathologists.

Studies to determine the cause of the bursting of chocolate-covered cream candies were conducted, in an effort to assist the confectioners to cut down the loss suffered each year from this cause. It was found that the activities of sugar-tolerant yeasts cause this bursting. A paper reporting the results appeared in Industrial and Engineering Chemistry, volume 19, page 353 (March, 1927), and was reprinted in the Manufacturing Confectioner for May, 1927.

SIRUP AND SUGAR

Nearly all the results of the bureau's work on carbohydrates done during this fiscal year have been reported in articles submitted for publication in various trade journals. These results may be summarized as follows.

NEW BLENDING SIRUP

Investigation of the production of unsulphured cane sirup of good quality from low-purity cane juice, in conjunction with cane-sugar manufacture, was continued. A good blending sirup was produced, and it is believed that the quality of this sirup can be further improved. In preparing it a method of filtration with diatomaceous earth and treatment with decolorizing carbon was followed. A quantity of blended sirup of good quality made from low-purity cane juice and low-purity refinery sirup was prepared and distributed by a cooperating cane-sugar producer.

CANE CREAM

The work on cane cream mentioned in last year's report was continued. Production of cane cream was undertaken on an industrial scale in coop-

eration with a cane-sugar producer in Louisiana. Several hundred cases were made, and commercial distribution was arranged in cooperation with a cane-sirup company for the purpose of learning the reaction of the consuming public toward this new product. Cane cream has a semisolid consistency, and from a physical standpoint consists of a mixture of sirup and microscopic sugar crystals. It is intended to be used as a spread on bread, sandwiches, griddle cakes, waffles, etc.

The development of new products from sugar cane tends to diversify its utilization and affords a greater flexibility in meeting variable market conditions, a matter of prime importance to the sugar-cane industry of the continental United States. This investigation illustrates the manner in which chemical technology can be applied for the purpose of facilitating the marketing of agricultural products, to the material profit of the producer.

CARAMELIZATION OF SUGAR

Investigation of the cause of the low caramelization point of some commercial sugars has revealed the fact that there are a number of impurities which may be responsible, even when present in minute quantities. Among them are phosphates, compounds of iron, oxidation products of carbohydrates, other organic impurities, and possibly colloidal substances in the sugar. No one of these is the sole cause, so far as is known at present. Amino acids and related compounds, if present, also increase caramelization, but investigation by means of a test developed during this work showed that amino acids are usually eliminated during the process of purification of the juice and crystallization of the sugar.

CONTROL OF LIMING

The work started last year for the purpose of devising a means of automatic control of the liming of cane juice in the production of raw cane sugar was practically completed. In cooperation with a raw cane-sugar factory, an experimental installation was operated during the season of 1926. This installation included apparatus for measuring electrometrically and recording continuously the pH values of the juice, and also accessory equipment to control automatically the addition of lime so as to maintain any desired constant pH value. Satisfactory results were obtained, and the working out of a few details is all that is required for the practical functioning of this method of control. Accurate control of the addition of lime overcomes the deleterious effects of an uneven reaction in the clarification of cane juice. It results in a greater elimination of impurities, increased rate of crystallization, and an additional recovery of sugar and an improvement in its quality. These are important considerations if maximum production and high quality are to be maintained.

CLARIFICATION OF CANE JUICE

An investigation was made of the various factors which influence the efficiency of the defecation of cane juice by the use of lime. In order to determine its relation to elimination of colloids, rate of settling of flocculated material, lime salts formed in the defecated juice, etc., special attention was given to the pH value at which the juice is limed. These factors were also considered in relation to the phosphate content of cane juice. Both small-scale and factory tests were made in which phosphate in appropriate form was added to juice deficient therein, and the beneficial effects due to greater elimination of colloidal material were measured by appropriate methods, including the dye test and ultrafiltration. In cooperation with the Porto Rico Agricultural Experiment Station, a series of experiments was made with juice from cane harvested from experimental plots from the same field on which fertilizers in various combinations had been applied. Some information was thus obtained which indicated the effect of different fertilizer constituents on the tonnage of cane and purity of juice, and likewise the effect of phosphate fertilizers from the standpoint of increasing the phosphate content of the juice as well as affecting the tonnage and sucrose content of the cane. This is of significance in view of the important part played by the natural phosphates of the juice in clarifying it by the use of lime as a step preliminary to the crystallization of sugar. Valuable information was also obtained on the quantity and type of colloids present in so-called refractory juices, such as those obtained from burned cane or cane that has deteriorated after being cut. It is believed that these data can be applied to overcoming the difficulty encountered in clarifying refractory juices.

Another investigation resulted in determining the proper conditions for adding lime to the mud obtained in the defecation of cane juice in order that this mud may be filtered readily without the formation of excessive lime salts or deflocculation of the mud. It was found that the treatment of the mud with lime is frequently not properly controlled. Some of the flocculated material is often peptized and placed in colloidal solution by this treatment, with the result that the colloid content of the filtered juice is actually increased, thus nullifying part of the beneficial results of previous defecation. In such cases the percentage of lime compounds in the juice is increased and they are present to a great extent in objectionable colloidal form, with resulting increase in viscosity of the juice. Data were obtained also regarding the relative advantages of single and double defecation, in order to compare the two methods from the standpoint of colloid elimination and formation of lime salts in defecated juice.

COLLOIDS IN PLANT JUICES

In preparing cane and beet juices for recovery of sugar by crystallization as in the customary procedure, nonsugar substances in the colloidal state interfere greatly with crystallization of the sugar, and removal of this material from the juice to the greatest extent possible is a critical step in the process of sugar production. It is therefore important that suitable methods be available for measuring, at least approximately, the quantity of colloids present in the original juice and at later stages of the process, in order to ascertain the extent of colloid removal and to serve as a guide to the improvement of the process. By improving a method used in soil-colloid investigations, it became possible for the first time to estimate the approximate quantity of colloids in sugar-plant juices under industrial conditions. This method, termed the "dye test," depends upon the use of the positively charged dye "night blue" to neutralize electrically the negatively charged colloids of the juice or sugar liquors. By the aid of this method, together with ultrafiltration, it has been found that the colloidal material in both cane and beet juices varies materially, depending upon such important factors as soil conditions and the variety and maturity of the sugar cane or sugar beets, as well as upon any deterioration between the time of harvesting and extraction of juice from the sugar plants. Ultrafiltration by means of standardized collodion membranes has revealed important differences in the character, as well as in the quantity, of the colloids in sugar-plant juices. This explains why some juices are clarified with greater difficulty than others, and suggests the direction in which a remedy for this condition may be sought. It has been found also that the dye value is an accurate index of the refining quality of raw cane sugar (aside from the influence of salts), thus demonstrating the fact that these differences in refining quality are due to nonsugar contaminants in colloidal form. The dye test may be used to predict the behavior of raw cane sugar in the refinery, and when correlated with observations in the raw-sugar factory will indicate means for improving the quality of raw sugar.

A method was devised whereby the clarification of starch conversion liquors in the production of corn sirup and particularly corn sugar may be improved. It was found that, contrary to the rule with cane and beet juices, the colloids in acid cornstarch-conversion liquor bear a positive electric charge. They may therefore be removed by mutual flocculation by adding an appropriate colloidal material which bears a negative electric charge when present in the liquor. It was found that this could be accomplished by the use, for instance, of certain aluminum compounds, such as sodium or calcium aluminates, or the natural clay bentonite. Experiments with bentonite showed that the elimination of colloids could be increased greatly over that obtained by the usual treatment of the acid-conversion liquor with sodium carbonate.

DECOLORIZING CARBONS

Further investigation was made of the action of bone char and other decolorizing carbons on sugar-plant colloids. In the case of raw cane sugar it was found that, under the usual operating conditions, carbon showed preferential adsorption of the so-called "irreversible" colloids as compared with those of "reversible" type. As it is the colloids of the irreversible type that are eliminated to the greatest extent by simple methods of juice purification, such as lime defecation, the importance of this observation is apparent. This means that,

in order that decolorizing carbons may be used with the greatest efficiency, irreversible colloids should be eliminated as thoroughly as possible in the preliminary clarification of the juice, so that the action of the carbon may be restricted as much as possible to the removal of reversible colloids, for which it is probably the most effective agent available.

In cooperation with one of the beet-sugar companies, investigation was made of the use of vegetable decolorizing carbons in beet-sugar production. Investigation was also started for the purpose of applying means for automatic electrometric control of second carbonation in the beet-sugar process, with the view of increasing the elimination of nonsugars at that point. This is to be operated by means of a potentiometer which continuously records the pH value and automatically controls the flow of carbon-dioxide gas.

STARCH

An investigation of the properties of various types of starch and their adaptation to industrial purposes was started, particular attention being given to effective utilization of typical starch-producing plants. Starch-making equipment on a semi-industrial scale has been installed.

VEGETABLE OILS

For the first time the character and quantity of the fatty acids present chiefly as mixed glycerides in the oil from the upland cottonseed, which constitutes the bulk of domestic production, have been determined. Fatty acids of the same kind were found, but in different proportions from those isolated several years ago from the oil of sea-island cottonseed. The findings, published in the Journal of Oil and Fat Industries, volume 4, page 131 (April, 1927), demonstrate conclusively the presence of stearic and arachidic acids in cottonseed oil, thus bringing to a close a long-standing controversy. The knowledge of the kind and quantity of the fatty acids in the form of glycerides that comprise the neutral oil is a step toward placing the cottonseed-oil industry on a scientific basis.

The composition of olive oil has been a subject of controversy in various countries for some time. It was not known whether arachidic acid was present, nor were the proportions of palmitic and stearic acids in oils from different sources known. The composition of olive oil from widely different regions therefore has been determined in the laboratory. The results of this extensive investigation, published in the Journal of Oil and Fat Industries, volume 4, page 63 (February, 1927), showed that arachidic acid was a minor but regular constituent of California, Italian, Spanish, and Tunisian olive oils. The samples of California and Italian oils were found to be very much alike in composition.

Methods for determining peanut oil in mixture with olive oil are being examined. This research was begun because large quantities of salad and cooking oil are now prepared in France by mixing 25 per cent of olive oil with 75 per cent of peanut oil. The possibility of this mixture being exported to the United States as pure olive oil makes it necessary to devise a method for detecting with greater accuracy this form of adulteration.

Work is in progress on the fat from the seeds of the *Ancoba echinatus* (Gorli) grown in Costa Rica. Like chaulmoogra and related oils used widely in the treatment of leprosy, this fat contains also a large quantity of chaulmoogric acid. The Ancoba is a tropical plant which produces seed two years after planting, as against the many years which the other species, being trees, require for fruiting, and could be readily grown on a commercial scale in the American tropics. If the ethyl esters prepared from the Ancoba fat prove to be as effective as those from the other related oils in the treatment of leprosy, such cultivation might prove warranted.

The material issued in 1919 as Department Bulletin 769 was entirely revised, brought up to date, and published as Department Bulletin 1475, Production and Utilization of Fats, Fatty Oils, and Waxes in the United States.

PROTEINS

The importance of a knowledge of the chemical composition of proteins in judging the value of feeds and feeding stuffs, as well as that of food for man, was pointed out in the Report of the Chemist for 1925. The research on proteins and vitamins conducted during this fiscal year is in large measure a continuation of that reported during the last few years.

VITAMINS IN SHELLFISH

Feeding experiments to determine the vitamin content of oysters and clams showed that both are good

sources of vitamins A and D. Oysters were found to be good sources of vitamin B, but clams, both hard and soft shell, were practically devoid of this vitamin. Vitamin A is a specific xerophthalmia (eye disease) curing and preventing vitamin; vitamin D is concerned with the metabolism of calcium and phosphorus; and vitamin B prevents and cures beriberi, a disease prevalent in the Orient.

GLUTELIN IN FLOUR

A new method for the separation of glutelin from wheat gluten, based on the observation that glutelin is precipitated from an alkaline solution by a very little ammonium sulphate, was published in the Journal of Biological Chemistry, volume 73, page 321 (May, 1927).

Heretofore wheat glutelin (like gliadin) has been generally considered as an individual protein. By means of the new method of preparation, it was possible to separate two glutelin fractions differing in properties and in chemical composition. These results will be of interest in connection with the study of the gluten or baking strength of wheat flour, as much of the work on this subject has been connected with the glutelin and gliadin constituents of wheat flour.

RELATION OF POLLEN PROTEIN TO HAY FEVER

The results of the collaborative study on the specificity of the albumin and proteose fractions of the pollen of certain plants toward hay-fever patients are given in the Southern Medical Journal, volume 20, page 257 (April, 1927). Four protein fractions were isolated from timothy pollen. A cutaneous sensitiveness to two or more of these fractions was shown by 63 per cent of vernal hay-fever subjects. Twenty-one per cent were sensitive to the proteose A fraction only and 15 per cent to the albumin fraction only. The glutelin fraction is of negligible importance. Proteose and albumin have been isolated also from ragweed pollen. Autumnal hay-fever patients exhibit cutaneous sensitiveness to one or both of these pollen proteins.

GLOBULINS

The study on the immunological relationships of the α and β globulins of several proteins, conducted during the last five or six years in collaboration with the University of Chicago, was completed, and the results were published in the Journal of Infectious Diseases, volume 40, page 326 (February, 1927). The delicate anaphylaxis tests on guinea pigs showed differences, as well as points of similarity, between the proteins studied that were in perfect agreement with those brought out by chemical analysis, thus confirming the work done in the laboratory on the α and β globulins of many seeds from which they have been separated.

FEEDY FISH

A biochemical investigation on the immature herring (used in sardine packing) to determine the cause of the decomposition of feedy fish, which makes them unacceptable for food purposes, was conducted. The results showed that the flesh of feedy fish is invaded by bacteria and by the trypsin of the pyloric ceca, but the visible evidence of decomposition—the softening of the abdominal wall—is due almost solely to the action of the trypsin, which is greater in quantity or more active than that in the ceca of non-feedy fish and readily escapes from the delicate and highly congested tubules, quickly penetrating to the adjacent tissues of the ventral wall.

INSECTICIDES AND FUNGICIDES

Several branches of the Department of Agriculture are engaged in the campaign against the depredations of insect pests and against the fungous diseases which annually cause severe losses on American farms. This bureau, in collaboration with the Bureaus of Entomology and Plant Industry, has directed much attention during the last fiscal year to studying the composition of insecticides and fungicides now in use and to developing new materials to answer the purpose more effectively or more cheaply.

INSECTICIDES

A method for the rapid field determination of sulphur on foliage and fruit treated with sulphur preparations was devised and will be published shortly.

A long series of experiments, involving many dialyses, to determine the composition of colloidal calcium arsenate and the best method of preparing it was completed. The results are being prepared for publication.

The general investigation of the chemistry of calcium arsenate, which has been under way for several years,

was concluded. Papers describing the preparation and chemical and physical properties of 12 crystalline arsenates of calcium, several of which are new, are being made ready for publication. Calcium arsenate is the most effective poison at present known for use against the cotton boll weevil, whose depredations cost the American cotton planter nearly $200,000,000 yearly. It is expected that more effective control of this insect may be had by the use of one or more of these new calcium arsenates.

Investigation failed to produce any satisfactory short routine method for determining the fineness of particles in commercial dust insecticides, such as lead arsenate. The method of settling in water gives a good idea of the size and relative proportions of the various particles present, but only at the expense of much time and effort.

The chemical composition and insecticidal value of plants, plant constituents, and synthetic chemicals were investigated, with a view to finding substitutes for insect flowers and developing new insecticides. Attempts were made to determine whether or not compounds corresponding to the active constituents of plants and other materials and having insecticidal action can be made synthetically.

The work on the oil and the crystalline alkaloid, delphinine, from the seed of stavesacre (a species of larkspur) is described in a paper entitled "Isolation of the oil and alkaloids of stavesacre seed," accepted for publication in the Journal of the American Pharmaceutical Association. The results of the investigations on the pyridine derivatives—the dipiperidyls, the dipyridyls, and "neo-nicotine"—will be described in a forthcoming series of papers. These experiments give promise of the manufacture of a synthetic nicotine substitute at $1 a pound. The present price of nicotine is $3.50 a pound.

FUMIGANTS

Some 2,200 laboratory fumigation tests with more than 300 organic compounds were made on grain weevils. As the result of these and of a number of fumigation tests in box cars loaded with wheat, and in boxes, chests, and a fumigating chamber, several highly promising fumigants have been developed. One of the most promising is a mixture of 3 volumes of ethylene dichloride with 1 volume of carbon tetrachloride, which may be used satisfactorily in a commercial fumigating chamber of the kind used by warehousemen. This mixture is noninflammable and cheap, has a pleasant odor, and, although effective in killing insects infesting carpets, clothing, upholstered furniture, etc., is relatively nontoxic to man. Tests with this new fumigant are described in the Journal of Economic Entomology, volume 20, page 636 (August, 1927).

The rate of vaporization of carbon disulphide and the development of an apparatus for its rapid volatilization are described in Department of Agriculture Circular No. 7.

Cooperative experiments with the Federal Horticultural Board on the penetration of hydrocyanic-acid gas generated from liquid hydrogen cyanide into the centers of bales of cotton showed that when introduced in liquid form hydrocyanic acid does not volatilize fast enough to penetrate the cotton. Penetration was obtained when the hydrocyanic acid was volatilized before it was introduced into the chamber. Along the Mexican border and at certain ports in the United States baled cotton is fumigated with hydrocyanic-acid gas in order that living specimens of the destructive pink bollworm may not be brought into this country in imported cotton.

OIL EMULSIONS

Oil emulsions are very effective and are extensively employed in controlling certain injurious insects. It is important that they be stable. When an oil emulsion breaks it separates into its components, oil and water, and vegetation is seriously injured by the application of a nonemulsified oil.

Studies showed that oil emulsions in which the drops of oil are large are much more toxic to aphids than those in which the drops are small. The oil in the small-drop emulsions does not adhere to vegetation as readily as that in the other type. The presence or absence of soap or cresol does not affect the toxicity of the emulsion. The results of this investigation are published in the Journal of Agricultural Research, volume 38, page 727 (April 15, 1927).

Rosin soaps when used with a little fish-oil soap formed very stable emulsions, but when used alone the emulsions broke rapidly.

TOXICITY OF COPPER CARBONATES

Copper carbonate is widely used as a preventive of smut in grain. Tests

were conducted in an effort to increase the fungicidal efficacy of copper carbonate, which is now widely used as a preventive of smut in grain. Attempts to prepare in the laboratory copper carbonate with more than 20 or 22 per cent CO_2, which most of the common commercial basic carbonates contain, were unsuccessful. It is believed that the variation in toxicity of the different carbonates on the market is due to the fineness or other physical properties of the dusts rather than to the chemical composition.

ATTRACTANTS AND REPELLENTS

Prior to the work done in the bureau to obtain satisfactory attractants and repellents for flies which infest animals, strongly odorous materials, such as pyridine, bone oil, fish oil, and nitrobenzene, were recommended as fly repellents. The investigational work in the bureau has shown that copper carbonate, an inodorous compound, is more effective in repelling flies from baits than any of the highly odorous materials tested. The effectiveness of pine-tar oil as a repellent dressing for wounds of domestic animals has been demonstrated. Large manufacturers of proprietary screw-worm fly killers and repellents are now using pine-tar oils as the basis of their preparations, instead of coal-tar phenols, as before. The results of this investigation have been published (Dept. Bul. 1472, March, 1927; and Industrial and Engineering Chemistry, vol. 19, p. 942, August, 1927).

BIBLIOGRAPHIES

Information concerning insecticides is widely scattered not only in entomological and agricultural journals, but also in the chemical, technological, patent, medical, pharmaceutical, and veterinary literature. No one abstract journal covers all this literature. In order to bring to the attention of entomologists and others interested in insect control promising new or little-known insecticides, a series of bibliographies has been inaugurated. The first of this series, entitled "Chemistry Bibliography No. 1, Chloropicrin," brings together all published information on chloropicrin, a "war gas," now receiving much attention as a fumigant. A supplement, bringing the references up to January, 1927, was issued later in the year.

The series of quarterly reviews giving abstracts of United States patents relating to insecticides and fungicides has been continued. This patent review has met with a cordial welcome from entomologists, and requests to be placed on the mailing list of the review have also come from insecticide manufacturers and chemical and biological research institutions. A paper calling attention to this quarterly review and emphasizing the value of the patent literature to economic entomologists was published in the Journal of Economic Entomology, volume 20, page 640 (August, 1927).

LEATHER AND TANNING

Among the important raw products of agriculture are hides and tanning materials, which, in turn, are converted into finished products indispensable to the proper development of our agricultural industries. The conservation of these raw and finished products is, therefore, a major field of research by this bureau. Work has been continued on the study and advocacy of correct methods of producing raw materials, on the development of new sources of such materials, and on the realization of longer-lasting leathers, by improved manufacturing processes, by more judicious selection of leather goods for the service intended, and by the exercise of proper care through the application of treatments to counteract undue deterioration.

CHROME-IRON TANNING

Research on the utilization of ferrochrome alloy as a raw material in mineral tanning has been brought to the point where large-scale tanning experiments with one of the progressive tanners of the country are under way. This industrial-scale work promises to confirm the conclusions drawn from laboratory experiments that either a straight chrome tannage or a joint chrome-iron tannage can be obtained with certain preparations made from ferrochrome, and also that the joint chrome-iron tannage yields a leather of a pleasing natural color at a lower cost than do the present-day chrome tannages.

NEW TANNING MATERIALS

Investigation of farm and forest products and wastes as possible new and needed sources of tannin has been continued. Among the materials examined which may deserve further consideration as sources of tannin are four barks from Mexico (*Lysiloma divaricata, Pithecolobium dulce, P.*

lanceolatum, and *Albizzia occidentalis*), showing from 22 to 29 per cent tannin; four samples of American spruce bark, showing from 10 to 20 per cent tannin; and several samples of mixed oak leaves, showing from 10 to 14 per cent tannin. Analyses of several other materials, including palmetto roots, English walnut shells, and black laurel bark, indicate that these materials offer little promise as a source of tannin.

The roots of Badan (*Saxifraga crassifolia*), a wild Siberian plant, are receiving much attention in Russia as a possible new commercial source of tannin. As these roots may be imported for the use of American tanners and because of the interest shown by the American trade in this material, a sample of the roots was obtained through the office of Foreign Plant Introduction, and examined. The roots contained 28.6 per cent tannin, a tannin content very promising for commercial development.

BOOKBINDING LEATHERS

As part of the program of work on more serviceable leathers, progress has been made during the last year in determining the causes of deterioration of leather and, in cooperation with the United States Government Printing Office, in interesting tanners in making bookbinding leathers of more durable tannage and better quality. Work has been continued on devising dressings to counteract the injurious effects of both the original acidity of the leather and that acquired through exposure to an atmosphere polluted with sulphur dioxide. Some of these dressings are being tried under actual library service in the New York City Public Library and in the United States Government Printing Office. The work so far done on bookbinding leathers warrants the conviction that the rational application of suitable dressings will greatly prolong the usefulness of leather-bound books and thus materially reduce the expense of leather binding.

Following the publication of the results of the study of the deterioration of bookbinding leathers by polluted atmosphere, described in last year's report, the library of the Royal Archives of Great Britain submitted a number of small pieces of leather taken from books dating from 1480 to about 1880 that had been kept in a pure atmosphere. Examination of these specimens showed the highest acidity to be 0.53 per cent and in 6 out of 10 cases the acidity was zero. These findings confirm the conclusion reached last year that atmosphere polluted with sulphur dioxide is one of the major causes of the deterioration of leather.

SELECTION AND CARE OF SHOES

How to get the most out of a pair of shoes is a question of decided interest to everyone. Suggestions and information on this matter are given in Farmers' Bulletin 1523, Leather Shoes, Selection and Care. The general application by wearers of shoes of the information in this bulletin would reduce their shoe bills at least 25 per cent, which would make a saving to them of more than $350,000,000 annually.

HIDES AND FOLLICULAR MANGE

The inferiority of leather made from hides of cattle with follicular mange having been shown, efforts were made to assist hide dealers and tanners in recognizing the condition before the hide is unhaired or immediately thereafter, in order that such hides may be separated and processed in the most suitable manner. The Bureau of Animal Industry, in cooperation with this bureau, instructed its field men to inspect livestock for mange and reports progress in its recognition. There seems to be no way to counteract the effect of follicular mange at the finished-leather stage. The disease must be prevented entirely or it must be cured before the animal is killed if its effects are not to show on the finished leather.

SUGARS IN TANNING MATERIALS

The sugar-yielding constituents of the various tanning materials play a major part in tanning leather. Much work has been done on their determination. Progress has been made in determining the total sugar in a number of the more important tanning materials and the influence of yeast on infusions of these materials.

MOISTURE IN LEATHER

Further work has been done on methods for determining moisture, one of the important constituents to be considered in any fundamental work on leather. Drying in a current of moisture-free air probably gives the most accurate results of any of the

methods studied, but no entirely satisfactory procedure for making this important determination has been developed thus far.

PAPER

RELATIVE HUMIDITY

Moisture materially affects the weight, strength, and durability of paper. The results of an extensive investigation to ascertain the effect of atmospheric humidity on the moisture content of paper of many kinds have been prepared for publication. These results, which are of interest not only to those who manufacture, sell, or use paper, but also to those engaged in testing it, show that the moisture content of paper is appreciably higher at 50 and 65 per cent relative humidity at 70° F. when these conditions are approached from a high humidity (80 per cent) than when they are approached from a low humidity (35 per cent). This may explain, in part at least, the fact that folding endurance results on a given sample sometimes differ widely when it is tested at different times and places, although the test strips are always conditioned at the same relative humidity and temperature.

PAPER FOR TEA PACKING

As the value of a tea is largely determined by its characteristic flavor, it is important to pack teas so that their characteristic flavors will be retained. It has been shown that bags made of parchment paper are much more resistant to the passage of both air and moisture than ordinary manila bags and that the flavor of the tea packed in such bags is retained much longer than when packed in ordinary manila bags.

FARM FABRICS

TOBACCO SHADE CLOTH

The research on increasing the durability of tobacco shade cloth has progressed favorably. Shade cloth treated with preservatives and untreated cloth for comparison have been exposed over tobacco near Windsor, Conn., for two-year and one-year periods. At the end of one year the yellow cloth (treated with lead chromate) showed a 5 per cent loss in tensile strength, the black cloth (treated with petroleum asphalt and lampblack) showed a 14 per cent loss, and the untreated cloth a 47 per cent loss. At the end of two years the tensile strength of the lead-chromate-treated cloth was decidedly greater than that of either of the others at the end of one year. Apparently, therefore, the lead-chromate treatment is superior to the other, so far as the preservative effect is concerned. Observation by an official of the Connecticut Agricultural Experiment Station showed that the color of the treated cloth has no effect on the growth or on the quality of the tobacco. The details of this work are given in an article entitled "Preserving Tobacco Shade Cloth," published in Textile World, volume 71, No. 19 (May 7, 1927). General application of the research work so far done would save tobacco growers about $1,000,000 annually. The investigation has reached the stage where commercial development of the processes is the next step.

GENERAL

Assistance and suggestions for waterproofing treatments and treatments to prevent the destruction of cellulose by microorganisms have been given to other Government bureaus and to manufacturers.

NAVAL STORES

TECHNOLOGICAL WORK IN THE FIELD

Gum cleaning.—The presence of large quantities of bark, chips, sand, and fine dirt in crude gum is one of the most serious obstacles in making rosin. These foreign materials not only make for great waste, but the fine dirt remaining in the rosin lowers its grade and causes much annoyance and loss to users. During the last season extended experiments with a gum-cleaning plant of the French type were carried on with the cooperation of one of the producers of southwestern Georgia. These experiments did not solve the difficult problem of thoroughly cleaning American gum. They showed that this type of equipment, while adapted to the cleaner gum of France, is not suitable for handling American gum, which is not only dirtier but also more viscous than French gum. Although several improvements in the equipment were made before the season closed, entirely satisfactory results were not obtained. The experiments in gum cleaning, however, have afforded valuable experience and have indicated the direction in

which further improvement must be made. They have also stimulated the interest of producers to a remarkable degree.

Steam still.—A simple but efficient steam still was designed for a progressive naval-stores producer of Mississippi who appealed to the bureau for assistance. Under the direction of the Government engineer and technologist an old-type fire still was converted into a steam still and put into successful operation. The results indicate that a steam still of this type is the most practical and least expensive kind for general use throughout the naval-stores industry and will produce the maximum yield of spirits of turpentine and highest grades of rosin. On the basis of this work the producer is converting a second fire still into a steam still.

General field work.—Work among producers to bring about better stilling procedure, so as to decrease losses and make higher grades of rosin, has met with great success. Technological studies at each still visited have enabled the bureau to improve the working at that place by devising better procedure to fit the needs of the place in question. The better procedures have been such as lead to the production of higher grades of rosin through an exact regulation of the still fire, the prevention of loss of turpentine through better condensing conditions, covered separators, painted and covered storage tanks, the elimination of losses from dirt by more careful straining and through cleaner gum, and the reduction of cost of operation through better coordination of the work. A simplified procedure for following and controlling a distillation, based upon the proportion of spirits of turpentine and water in the distillate throughout the distillation, was worked out and written up as a guide for stillers. Its general application would give producers many thousands of dollars more income through the production of better grades of rosin. This procedure is being rapidly adopted by producers.

LABORATORY STUDIES

Rosin from cup-cleaning gum.—Much so-called B-grade rosin made from gum recovered in cleaning turpentine cups or made with crude equipment was found to be partially decomposed and partly converted into pitch, owing either to the presence of a great deal of dirt in the raw material or to excessively high heating during distillation. Such a product can not be sold under the naval stores act as rosin. From examination of a number of samples of this product it has been possible to tell producers how to guard against such decomposition, which renders the product unsatisfactory for many purposes and which therefore brings the producer less money.

Rosin fires.—In heating rosin in large kettles it may flash or even burn under certain conditions if fire is brought near it. Preliminary investigations conducted in response to an appeal from users of rosin indicate that gum rosin will flash in the Cleveland open cup at about 410° F. and will burn at about 465° F. It was found, however, that if the rosin contains a small percentage of residual mineral oil, as it sometimes does when it has been reclaimed from dross by dissolving in mineral oil or naphtha and subsequently distilling off the solvent, it may flash at as low as 220° F. and burn at about 415° F. Knowledge of these facts are of service to rosin users in enabling them to buy suitable rosin of low fire hazard, and in showing that extra precautions must be observed in heating reclaimed rosin to high temperatures.

Viscosity of rosin.—Investigations, in cooperation with producers, users, and the American Society for Testing Materials, on the development of simple methods for determining the softening point of rosin, and on the degree of viscosity or fluidity at a given temperature have been continued. Knowledge thus gained is essential in avoiding serious difficulties and losses when rosin is used for certain purposes. The work has shown that none of the methods commonly used is entirely satisfactory. Two new methods, one of which was originated in the bureau, are promising, and work is being continued on them.

Opaque rosin.—Opaque rosin is objectionable to the user and a loss to the producer. The question has arisen as to how much water opaque rosin contains. An investigation has shown that opacity may result from the presence of as little as 0.2 per cent of moisture, although usually opaque rosin contains much more. As the water content increases the rosin gradually becomes translucent, then opaque, and finally powdery. Three per cent of water will give rosin a white, opaque appearance. A sample of powdery, opaque rosin was found to contain approximately 20 per cent of moisture.

Constituents of turpentine.—Progress has been made in the investigations to identify the constituents of the several kinds of spirits of turpentine, including refined turpentine recovered as a by-product in making paper pulp from resinous woods by the sulphate process. Such turpentine is readily distinguished from other turpentines by the odor, and it contains small percentages of sulphur compounds. Contrary to previous opinion, however, the indications are that the strong odor is not due entirely to the sulphur compounds present. Assistance in purifying and refining sulphate-wood turpentine has been given to those engaged in recovering and marketing it. It is necessary under the naval stores act, and also for technical and financial reasons, to distinguish between the several kinds of turpentine, especially to identify mixtures. The aim of these investigations is to make such recognition more certain than it now is.

Turpentine types.—Spirits of turpentine is sold in the primary markets as "water white," "standard," "one shade," and "two shades" in color. Proposed permanent types for these grades have been prepared during the year in a form similar to the rosin standards, have met with the practically unanimous approval of the trade, and are proving of very definite service.

COOPERATION WITH FIRMS AND INDIVIDUALS

Many problems of the industry are first brought to the bureau's attention by business firms in trouble. In order that the industry and the general public might be better served, cooperation has been extended during the year to many individuals and manufacturing concerns in solving problems arising in the manufacture, transportation, handling, and use of naval stores. This has involved the analytical examination of several hundred samples of naval stores of various types and of products made from them. The information thus obtained has and will enable the bureau promptly to help others also, when they are in need.

AMERICAN ROSIN STANDARDS APPROVED BY FRENCH TRADE

Until recently the naval-stores trade of France has had no definite and permanent standards for rosin. Through cooperation with French leaders, the French trade has now adopted as official for French rosin the color values and nomenclature of the United States standards from B to WW inclusive. Steps are being taken to bring into agreement the paler shades, i. e., the American X and the French Y grades. This is the initial step in an effort to make rosin standards universal, and is a long step forward in putting the naval-stores business of the world on a uniform basis.

STATISTICS

A statistical report issued in December, 1926, covered the industrial consumption during the calendar year 1925 of turpentine, rosin, and mineral oil thinners, showed the stocks of turpentine and rosin at the ports and distributing points and in the hands of consumers on the last day of the 1925 naval-stores season, and gave the production statistics on both gum and wood turpentine and rosin during the 1925 season, stocks at the stills as of March 31, 1926, and export and import data for the 12 months corresponding to the producing season. A report on the number of new turpentine cups sold to be hung in the turpentine forests for the 1927 season was also published. These statistics serve to keep producers and users of naval stores informed on trade conditions.

COLORS

Research on coal-tar dyes begun many years ago in connection with the enforcement of the food and drugs act has been greatly expanded. As pointed out in previous reports, many dyes are studied in the laboratory at Arlington, Va., with a view to developing new ones and improving on present methods of manufacture.

During the fiscal year progress in working out analytical methods for pyronines and neutral red was reported. Satisfactory procedures for the analysis of ethyl eosin and the sudans were found. An iodimetric method for methylene blue and a method for the detection of subsidiary dyes in methylene blue were perfected.

Data on the solubility in water and in alcohol of 54 biological stains were obtained and published.

The continuation of the sulphonation studies on basic fuchsins has made possible the manufacture of acid fuchsins of excellent staining characteristics.

PLANT DUST EXPLOSIONS AND FARM FIRES

The research this year to determine the causes of dust explosions in industrial plants and to develop methods for their control and prevention has been confined almost entirely to grain-handling and milling plants. The investigations on the project, however, have indicated that extensive losses of life and property have occurred in practically all lines of industry where combustible dusts are produced during manufacturing operations. This bureau is the only scientific Government bureau studying the dust-explosion problem in industrial plants, and it has frequently been called upon to render assistance to the chemical-engineering industries where new processes have introduced additional hazards. The bureau recognizes the necessity of extending this work to include industrial plants and chemical-engineering industries of all types, as well as the importance of providing facilities for large-scale explosibility testing.

INERT GASES

The value of inert gases, such as boiler-flue gas, for the prevention of dust explosions and fires in milling and conveying systems was determined under practical operating conditions in the experimental plant at Arlington, Va. The damping effect of various percentages of inert gases and the effect of various densities in the dust cloud were ascertained and demonstrations before representatives of a large number of industrial companies and organizations interested in dust-explosion prevention were held. As a result of this research and demonstration, several companies have installed inert-gas equipment and others are planning to do so.

CONTROL OF STATIC ELECTRICITY

Past investigations having shown the danger of static electricity as a source of ignition of a dust cloud, attention was directed to the development of a nonstatic leather-belt dressing. Although charges of static electricity were eliminated under laboratory conditions of testing, difficulties, such as stretching of the belt and lowering the coefficient of friction and flexibility of the leather, were experienced during actual working conditions. A mixture having as a base tallow and castor oil thinned with pine oil was satisfactory in the laboratory but in actual practice caused stretching of the leather. Other dressings were tested, the most successful so far being a mixture of fish glue, glycerin, an emulsified sulphonated oil, and lampblack. As this mixture has some objectionable qualities as a coating for a new belt, experiments are now under way to produce a composition having a flexible shellac base.

IGNITION TEMPERATURE DETERMINATIONS

In developing methods for the prevention of dust explosions it is important to know the ignition or burning temperature of the various dusts. Accordingly, the ignition temperatures of the following dusts were determined: Cocoa, pyrethrum flowers, cloves, tobacco, wheat smut, wheat elevator, corn elevator, oat hulls, wood pulp, wood flour, lignone, leather, fertilizer, cornstarch, hard wheat flour, paper dust, and cellulose prepared from filter paper. These temperatures range from $237°\pm5°$ C. for cocoa to $350°\pm5°$ C. for cellulose, in the order given. For the dusts containing cellulose the higher the content of cellulose the higher the ignition temperature.

EFFECT OF OXYGEN DILUTION

As a result of the industrial interest in the use of inert gases for explosion control, laboratory work was carried on to determine the oxygen dilution necessary to prevent the propagation of flame in certain dust clouds, such as cork, pyrethrum flowers, and ground oat hulls. Special experimental apparatus was designed to determine the limits of concentration for explosive dust clouds.

DUST TESTING

During the year explosibility tests were conducted on a number of samples of dust submitted to the bureau by manufacturers, insurance companies, and other agencies. As a result of these tests, assistance was given in the adoption of measures for the reduction or elimination of the dust-explosion hazard in the industry concerned.

DUST-EXPLOSION HAZARDS COMMITTEE

The dust-explosion hazards committee, under the leadership of the bureau, met in New York, N. Y., on January 10 and in Chicago, Ill., on May 10. During the year the regulations for sugar and cocoa pulverizing sys-

tems were combined into one set of regulations and important revisions in the pulverized fuel regulations were made. The Department of Agriculture has accepted joint sponsorship with the National Fire Protection Association for the preparation of codes for the prevention of dust explosions in the dusty industries and the codes already prepared have been accepted and approved by the American engineering standards committee.

During the year the dust-explosion work of the bureau was presented at a large number of meetings and conventions. Special assistance was given the National Association of Fire Fighters in the adoption of methods for the prevention of explosions during fire fighting, to assure protection to the lives of firemen in connection with the control of fires in industrial plants.

COOPERATION WITH STATE OFFICIALS

A definite plan of cooperation with the State officials directly concerned with industrial-accident prevention was arranged. Under this plan the bureau engineers will assist the State officials in the investigation of dust explosions and make available the experience of the bureau in the adoption of precautionary measures.

FARM FIRE PROTECTION

The annual fire loss in the United States is about $570,000,000, and it has been estimated that approximately $150,000,000 of this amount is due to losses on farms and in rural communities. These figures do not take into consideration the losses caused by deterioration and spoilage of farm products which have a relation to spontaneous combustion, now recognized as one of the principal causes of farm fires. It has been estimated that 3,500 lives are lost annually as a result of fires on farms and in rural communities.

The farm fire protection committee of the National Fire Protection Association, in which the bureau has the leadership, held two meetings during the year, one at Columbus, Ohio, on February 15, and the other at Chicago, Ill., on May 9. The committee, which includes representatives of a number of national organizations, is making a study of the causes of farm fires and is cooperating with the Department of Agriculture in the development of methods of control and prevention. The bureau cooperated with the agricultural committee of the national fire waste council of the Chamber of Commerce of the United States in a special campaign to reduce fire losses, with special attention to agricultural communities.

METHODS OF ANALYSIS

In the course of the many examinations it is required to make, the bureau is constantly improving upon old methods of analysis and devising new ones. As pointed out in the Report of the Chemist for 1925 (p. 13), much of this work is done in collaboration with the Association of Official Agricultural Chemists.

Some of the methods developed during the last fiscal year are reported in other paragraphs of this report. Others are a method for the quantitative determination of ether in medicinal products, a calcium-chloride method for separating alcohol and ether, a method for the estimation of caffeine, aspirin, and cinchophen in admixture (to be published in Industrial and Engineering Chemistry), and a method for the detection of yohimbine in the presence of strychnine. A special fractional distillation outfit was consfructed for the fractionation of both steam-distilled wood turpentine and gum turpentine, in an effort to devise a method for the determination of the composition of spirits of turpentine, with special reference to the minor constituents.

The importance of the application of the optical-immersion method to the identification of crystalline substances has been demonstrated. It is particularly useful in the identification of alkaloids and other organic compounds and is applicable to a large variety of crystalline substances. As this method can often be conducted much more quickly than chemical determinations, it is of special value in supplementing the usual chemical methods. The method calls for the petrographic microscope. Certain conditions having been complied with, the indices of refraction characteristic of the crystalline material are determined, reference ultimately being made to tables of refractive indices of substances of known chemical composition for the purpose of establishing the identity of the material. When the material under examination is crystalline, only small quantities are available, and quick and accurate results are sought, the optical immersion method is specially valuable.

COLLABORATION WITH OTHER BUREAUS AND DEPARTMENTS

As in past years, the bureau conducted a great deal of analytical and investigational work for other branches of the Government service.

One of the chief lines of this work was that done for the Post Office Department as part of the enforcement of the fraud order law, an act which, among other things, may debar the use of the United States mails to anyone found guilty of abstracting money from the public through the mails by means of false and fraudulent claims and representations. As a result of the examination of samples in the bureau, 79 cases were brought under this law. Among the preparations which called for the issuance of fraud orders were a powder that, according to its manufacturer had only to be sprinkled in the shoes to cure many diseases; a preparation advertised as a cure for tuberculosis, pneumonia, and other pulmonary disorders, but found on analysis to contain no ingredient which alone or in combination would effect such a cure; and an alleged cure for all ailments of the eye—a dry wine containing 0.25 per cent of zinc sulphate. Many preparations for which false therapeutic claims were made were voluntarily withdrawn from the market without recourse to fraud-order action. The manufacturers realized the fraudulent nature of their business in view of what had happened to others and discontinued the use of the mails for selling their preparations.

Many samples of drugs and narcotics were examined for other departments and bureaus. Some 70 samples of biological stains were analyzed for the Commission on Standardization of Biological Stains and analytical data on about 40 stains were supplied to the Army Medical Museum.

Hundreds of samples of foodstuffs were tested for five other departments, for the General Supply Committee, the Commissioners of the District of Columbia, the Panama Canal Commission, the Shipping Board, the Federal Trade Commission, and various bureaus of the Department of Agriculture.

All the tea bought by the Navy, the Marine Corps, the Veterans' Bureau, the Department of Justice, the General Supply Committee, and the District of Columbia was examined by representatives of the bureau. The bureau's tea examiners appraised all tea containers for the United States Customs Service.

Two hundred and thirty-five samples of special arsenicals, fluorides, silicofluorides, and cyanides were analyzed for the Bureau of Entomology and 70 samples of disinfectants were tested for other branches of the Federal service.

Cattle foods were analyzed for the Forest Service, the Bureaus of Agricultural Economics, Animal Industry, and Plant Industry of this department, for other departments, and for the Panama Canal Commission.

Assistance was given the Federal Specifications Board in preparing specifications for bag and other leathers and for paper. Bookbinding leathers were examined for the Government Printing Office, and the acid content of several samples of paper thought to have deteriorated during storage was tested for that institution. Many kinds of paper were tested for other offices of this department and for the District of Columbia.

Jute twine and turpentine were tested for the General Supply Committee.

REGULATORY WORK

In 1907 the Bureau of Chemistry was charged with the enforcement of the Federal food and drugs act; in 1920 the enforcement of the tea act was transferred from the Treasury Department to the Bureau of Chemistry; and three years later the enforcement of the naval stores act, passed in 1923, devolved upon the bureau. The enforcement of these three acts entails a certain amount of analytical and investigational work, in addition to the inspectional and administrative work involved. The outstanding results of these activities, both inspectional and investigational, during the last year follow.

FOOD AND DRUGS ACT

A brief history of the Federal food and drugs act and the details of the plan of its operation were given in the Report of the Chief of the Bureau of Chemistry for 1926. The same plan of operation was followed this year.

Table 1 lists the food and drug products involved in court actions during the fiscal year just ended.

TABLE 1.—*Summary of prosecutions and seizures under the food and drugs act during 1927*

Product	Prosecutions	Seizures	Total
Alimentary paste		25	25
Baked products	8	1	9
Beverage ingredients (malted milk, sirup)	1	6	7
Beverages		2	2
Cereals		1	1
Chocolate coating		2	2
Cocoa		1	1
Coconuts		1	1
Coffee	1	3	4
Confectionery		3	3
Dairy products:			
Butter	24	79	103
Milk (powdered)		1	1
Drugs:			
Crude drugs	2	5	7
Remedies	97	63	160
Eggs:			
Shell	5	17	22
Frozen		7	7
Feeds	41	98	139
Fish		34	34
Flavoring extracts		4	4
Flour		2	2
Fruit:			
Canned		15	15
Dried	4	40	44
Fresh	2	165	167
Frozen		1	1
Ice cream cones		1	1
Jams, jellies, and preserves		8	8
Nuts		19	19
Oils	3	1	4
Oleomargarine		3	3
Olives		1	1
Pickles		1	1
Sauerkraut		1	1
Shellfish	51	23	74
Shrimp		1	1
Sirup		1	1
Spices	5	9	14
Vegetables:			
Canned	9	39	48
Fresh	3	6	9
Vinegar		1	1
Water	2	4	6
Total	258	695	953

The number of seizures and prosecutions instituted by the Department of Agriculture under the Federal food and drugs act is in no way set forth as an index, or even as an indication, of the amount of work done by the Bureau of Chemistry in the enforcement of this act. It would be a reflection on the efficiency of the bureau if the ratio of seizures and prosecutions to the number of samples collected from year to year did not diminish progressively. It is safe to say that to-day the greater proportion of the samples collected by Federal inspectors show no violation of the law, or, if they do, the violations are minor and usually can quickly be corrected by correspondence or other informal means. A list such as that given in Table 1, however, serves the purpose of acquainting the public with general conditions in the food and drug industries.

DOMESTIC FOODS

In glancing over Table 1 even the casual observer will probably pause to wonder why the department found it necessary to seize 25 shipments of such an apparently harmless substance as alimentary paste, or why 50 seizures of grapefruit and 75 seizures of oranges were made. Unusual activity in any given direction is sometimes caused by the failure of manufacturers to observe new rulings of the department, but more often it is due to a change in natural conditions over which the department has no control.

On January 15, 1926, the Bureau of Chemistry issued an announcement to manufacturers, shippers, and importers of alimentary pastes, warning them that pastes of every description containing color added to simulate egg paste were in violation of the Federal food and drugs act, even though the presence of the added color was declared on the label. This pronouncement was not issued as a surprise to the trade, but reaffirmed a similar announcement made in 1915. It was made to combat the deception which results from the sale of artificially colored paste for egg paste, and to meet the ever-increasing traffic in egg paste of all types. A very liberal period was allowed manufacturers and dealers to adjust their manufacturing processes and to dispose of the stocks on hand at the time the announcement was issued. In spite of the three-month period of grace, however, many shippers either failed to dispose of their stocks or deliberately made misbranded shipments in the face of the definite prohibition by the department.

The seizure of 142 shipments of citrus fruit, principally oranges and grapefruit, was the result of natural causes. The cold wave which spread over almost the entire citrus belt of Florida in January caused the freezing of much of the citrus fruit then ripe or ripening on the tree. Frosted fruit is usually very dry and lacking in juice when it reaches the consumer. Department announcements were issued immediately after this freeze to warn citrus growers and shippers of the worthlessness of dry or frozen fruit and to remind them of the department's intention and duty to take regulatory action against any shipments

found to be dried beyond an announced tolerance. Notwithstanding these warnings, as well as those of the inspectors and chemists who were constantly in the field during this period, and the unfortunate experiences of other shippers in previous years, an effort was made by the less scrupulous shippers to place this unfit fruit on the market. The result of their unlawful attempts is shown by the number of oranges, grapefruit, and tangerines seized. Most of these shipments were carload lots, and by the time an effort could be made to salvage the fruit it was either decomposed or of such little value that salvaging was impracticable. Many of these shipments could be apprehended only with the excellent cooperation of State and municipal officials, without whose assistance the department would often have been helpless.

The large number of seizures of butter and feeds noted in Table 1 is not unusual. These are standard commodities shipped in vast quantities from every section in the country during every month of the year. Both are open to gross abuse by manufacturers. Butter has been defined by Congress by special act, but many manufacturers still ship a product that is either low in butterfat or short in weight. Much of the illegality can be charged to the new creameries springing up each year, which disclaim any intention of violating the law or are unfamiliar with the details of the business in which they are engaged. The food and drugs act applies to feeds for animals as well as to food for human beings. Feeds are purchased by dealers and feeders on a protein basis, and any decrease in protein from that specified on the label constitutes a fraud against the purchaser.

The Boston station gave particular attention this year to the blueberry industry in Maine for the purpose of continuing the maggot-control work of previous years and to obtain cooperation with canners in rejecting raw materials unsuitable for canning. The industry since the beginning of this campaign has shown a splendid spirit of cooperation, and the last report indicates that various modifications of the Howard-Stephenson type of washer are in use in most of the factories and working efficiently. The work of the last few years has produced very gratifying results. The industry has passed through a period of transition. Instead of the desire to pack everything brought in from the field, the packers now realize the folly of this procedure and of their own accord are taking advantage of every scientific development to place a high-grade product on the market.

Past reports have discussed at some length the bureau's work on sardines and salmon. Neither of these industries to-day requires the close personal attention of the staff laboratories or the field stations.

In the past a Government representative has been in Maine during the entire sardine-packing season, making sanitary surveys, examining fish at the canneries, and assisting the packers in every way possible to pack a higher-grade product. It is not reasonable, however, to expect the department to keep up this supervision indefinitely, especially as the packers by their own efforts are trying to make the industry a credit to the State. Members of the Boston station remained in the sardine-packing area throughout the entire summer of 1926. This will probably be the last time the department will take such active charge of the work, unless conditions make it essential to have an inspector in the neighborhood at all times. In the future inspectors will make the rounds of the factories as frequently as time permits.

The 1926 pack showed fewer decomposed fish than ever before, according to reports from the various packers. The inspection of fish at the factories is an advantage to both the Government and the packer. Because it results in the packing of a better grade of sardines, the packer may safely pack high-grade goods without fear that his competitor can pack an inferior product, thereby destroying his market. Most, if not all, of the packers have welcomed Federal inspection and have heartily cooperated. As Maine sardines are sold for the same price, regardless of the quality of the individual packs, there has been a great incentive for packers to use fish of an inferior grade which can be obtained from the boats at a much lower price than the better grades. If one unscrupulous packer adopts all the short cuts that are presented to him, such as packing inferior fish and reducing his price, all the other packers must fall in line and adopt the same practices or suffer a financial loss. This careful plant inspection has obviated the necessity for intensive sampling by the Government after shipment.

For the last four years the bureau regularly has sent an inspection party into southeastern Alaska to visit salmon canneries, primarily to determine if possible which canneries are likely to ship bad fish at the end of the season. This plan has worked efficiently, but, in spite of a great improvement, an extremely large quantity of partly decomposed fish was shipped during 1926. The bureau found it necessary to seize thousands of cases of salmon packed by some of the largest and supposedly most reputable organizations on the Pacific coast. Obviously the industry has not yet reached that permanent reformation for which the bureau had hoped and which was indicated by the great improvement of the year before. Most of the salmon seized last year, however, came from the regions farther north than the inspectors have ever traveled. This may be a coincidence only, and no attempt is made to explain the presence of the large quantity of decomposed fish on the market by this fact. In concluding their report of the trip, the inspectors stated that, although a marked improvement was noted in central and southeastern Alaska, owing to the bureau's control work, as a general rule it is possible to visit few of the canneries more than once during the season and often the canner knows just when the inspector will reach his cannery. This, of course, gives ample time to clean up and dispose of questionable fish which might otherwise be placed in cans.

As usual, it was necessary to pay particular attention to egg products of various types. At stated intervals warehouses known to hold frozen eggs were surveyed, with a view to the seizure of all lots of decomposed or partially decomposed eggs. More than 6,000 cans of eggs were seized by the Government and in addition a half million pounds were embargoed by State and city officials as the result of a joint survey by State, city, and Federal officials in a half-dozen midwestern cities.

The practice of shipping so-called incubator eggs in interstate commerce is a growing source of annoyance to food-control officials. One hatchery in Pennsylvania, with an egg capacity of 500,000, was found to be removing unhatchable eggs after they had been in the incubator for as many as 7 to 10 days. These were recandled and those showing clear were shipped to New York or other large cities.

DOMESTIC DRUGS

The department's campaign against misbranded patent or proprietary medicines has continued without interruption. This work calls for the consideration of every label, carton, and circular used in connection with the sale of these products, and in no field of manufacture and sale is the advertising so prolific as in the patent-medicine business. Most of the new products encountered were falsely and fraudulently labeled and required either correspondence or personal interview for correction. In a great many cases seizure action and prosecution have been necessary.

One of the outstanding features of the work on drug products was the completion of an investigation begun several years ago which covered all pharmaceutical preparations found on the market. During this last year a high proportion of all the pharmaceutical samples collected in the inspection districts were either grossly deficient or contained an excess of the active medicinal ingredient. Owing to the variations in the individual tablets, caused by imperfect mixing of the ingredients, and to the natural deterioration of some of the ingredients, a notable example of which is nitroglycerin, the preparation of uniform pharmaceutical preparations is exceedingly difficult. The use of adequate control measures in manufacture, however, should keep from the market pharmaceutical products showing wide discrepancies from the label declaration.

Ampuls, preparations intended for hypodermic injection, and distributed in glass containers or ampuls, supposed to be in condition for instant use, were also investigated. It having been discovered that pharmaceutical tablets often vary widely from the declared strength, a survey of the ampuls on the market to determine whether or not the same variations existed was inaugurated. Some of them showed negligible variations, but a great many showed amazing deficiencies or a corresponding excess of the active ingredient. Little more than the laying of a foundation could be done this year. One hundred and thirty-one samples were analyzed, and as rapidly as possible the results were tabulated, and the appropriate pressure was exerted on the manufacturers whose products were found unsatisfactory.

Attention has been directed also to antiseptics and such preparations as acidophilus and Bulgaricus tablets and cultures. Nearly 50 per cent of the samples of products sold as mouth washes, nasal sprays, etc., and labeled as antiseptic or germicidal solutions, examined were wholly ineffective as either an antiseptic or a germicide. As a matter of fact, some of the samples contained viable bacteria. Within the last year or so the market has been flooded with so-called acidophilus and Bulgaricus preparations. The output of 21 manufacturers of these substances was analyzed during the summer of 1926. The result of this short investigation led the bureau to conclude that most of these products are useless. To be exact, 77, or 90 per cent, contained few or no active organisms, and those that did show acidophilus or Bulgaricus organisms contained them in such small amounts that it would be necessary to consume unheard of quantities to derive any benefit. The trade has been warned with respect to the general uselessness of these preparations, and notified of the Government's intention to rid the market of misbranded, deteriorated, contaminated, or otherwise illegal pharmaceutical preparations.

Early in 1926 several deaths were attributed to the use of impure anesthetics, ethylene being the agent used. The bureau was promptly notified and immediately began an investigation into the quality of anesthetics on the market. Several hundred samples were collected and analyzed and a great many seizures were consummated. At the present time the manufacturers themselves are engaged in a comprehensive investigation as to the cause of the deterioration of ether. The deterioration of ethylene was found to be due to lack of control in the manufacturing process.

IMPORTED FOODS AND DRUGS

The Federal food and drugs act provides for inspection of all imported foods and drugs at the time the shipments are offered for entry, when they are examined by collectors of customs or appraisers of merchandise in connection with the requirements of the tariff act. It provides also for the exclusion of all adulterated or misbranded foods and drugs. All such goods are not excluded, however, for while they are still in customs custody or under bond the privilege is granted of relabeling those that are not grossly misbranded and of resorting or reconditioning those not intentionally adulterated. If such relabeling or reconditioning brings the goods within the requirements of the law, they are allowed entry; if not, they must be exported. Although inspection is made of all goods and the invoices covering them, samples are not taken of all shipments, but only of those suspected of being adulterated or misbranded. Past experience with products of similar nature and a knowledge of the practices of shippers make possible the control of many imported foods and drugs by means of a relatively small number of samples.

Practically all fields are covered generally, but certain fields are made the subject of special study from year to year. The following received particular attention during the fiscal year just ended.

Cocoa beans.—The high price of cocoa beans from Africa, the largest source of supply, has probably induced shippers to send forward many shipments of border-line or excessively moldy or wormy beans. As a result, not a few shipments have been detained and exportation required or special use permitted, which would eliminate their employment in making cocoa powder or other chocolate products. Similar action was taken on many shipments from Haiti. To devise some method of improving the quality of cocoa beans imported from the Gold Coast of Africa, a bureau representative visited the cocoa-bean plantations there, inspecting the product from the time it was harvested until it was loaded onto the ocean-going boats. Based on his recommendations, various requirements are now being made of the native growers and shippers, which, it is believed, will greatly reduce the number of shipments of cocoa beans detained at the port of New York because of excessive mold.

Figs.—Owing to the campaign against figs which have become moldy or show evidences of the action of larvæ or worms, a somewhat steady improvement has taken place in the quality of figs shipped to the United States. A special warning issued early in the year that every attention must be given to such improvement produced particularly noticeable results. A lower tolerance on objectionable figs has been issued, to take effect the coming season.

Nuts.—As a result of special attention through several years, a marked decrease was noted this year in the

number of shipments objectionable because of worms or mold, a common condition not long ago. Greater care in drying and in shipment of chestnuts has cut down the number of objectionable importations. Less than 5 per cent of the shipments of walnuts and filberts were detained. The percentage of Brazil nuts and cashew nuts detained because of moldy or wormy conditions was about 15 per cent. Shipments of almonds showed little deterioration from these causes.

Medicinal preparations.—Many shipments of medicinal preparations are detained because of false therapeutic statements. The number of shipments of products considered to be grossly misbranded, in that they were represented as treatments for such serious diseases as cancer, tuberculosis, influenza, and diabetes, when in fact there was no basis for the statement, was unusually large. Some of these products were preliminary shipments from a firm specially organized to exploit the product in question. Other shipments would have followed but for the action taken.

FOOD STANDARDS

The food standards committee, formerly known as the joint committee on definitions and standards, is composed of three representatives from the United States Department of Agriculture, three from the Association of American Dairy, Food, and Drug Officials, and three from the Association of Official Agricultural Chemists. Two meetings only were held during the year.

A definition and standard were adopted for cultured skim milk, cultured buttermilk, and a new definition was adopted for rice. The definition for sweetened condensed milk was revised in order that the requirements for milk entering into its composition might correspond to those for milk as defined. The definitions and standards for alimentary pastes and macaroni products, including noodles, were revised and adopted.

Several hearings and conferences were held upon the subjects of cultured skim milk, so-called process cheese, cream meal, a product of corn, and so-called smoked salt.

Schedules were prepared for the consideration of the committee on purified middlings (farina) and semolina, and on a series of strained tomato products. After discussion, action upon the proposed definition and standard for ice cream was deferred.

Since the last report a number of the definitions and standards adopted by the department, upon the recommendations of this committee, have been adopted by State food-control officials. Their general acceptance of these standards is resulting in greater uniformity in regulation of the sale of food products throughout the country.

CERTIFICATION OF COAL-TAR COLORS

The extensive chemical and physiological tests to which all dyes offered for inclusion on the list of certified colors are subjected were concluded on a new green dye, offered as St. Louis green and finally accepted as fast green FCF. Feeding and toxicological experiments on this dye and on light green SF yellowish and Guinea green B, the two green dyes previously certified, showed that in general the fast green FCF and the light green SF yellowish are about on a par and are superior to Guinea green B by one-half.

A report on the results obtained in the spectrophotometric study of the effect of the permitted coal-tar colors upon the hemoglobin of the blood has been prepared for publication. It was shown that these dyes, when mixed with defibrinated blood of cattle, cause the conversion of oxyhemoglobin to "reduced hemoglobin," a normal reaction. No evidence of methemoglobin, a danger signal, following the use of any dye on the permitted list could be detected.

Table 2 shows the quantities of food colors certified during the year, as compared with the quantities certified during the preceding four years.

TABLE 2.—*Coal-tar food dyes certified, 1923–1927*

Year	Straight dyes	Repacks	Mixtures	Batches	Number of firms	
					Total	New
	Pounds	*Pounds*	*Pounds*	*No.*		
1923	250,756.0	20,216.00	239,614.00	633	27	4
1924	232,305.0	26,956.00	286,148.00	724	30	6
1925	315,848.0	39,013.79	284,060.00	883	34	9
1926	311,434.5	32,234.00	304,040.22	1,075	38	14
1927	277,044.0	28,844.13	374,804.28	1,172	52	10

The falling off in the total quantity of straight dyes certified has been more than offset by an increase in the quantity of mixtures and in the number of batches submitted for analysis.

Seven batches of straight dye, one repacked straight dye, one repacked mixture, and 26 mixtures were rejected.

Miscellaneous Circular 52, which gives the procedure for the certification of coal-tar food colors, has been revised and will be issued shortly as Service and Regulatory Announcements, Food and Drug No. 3.

FOOD-CONTROL INVESTIGATIONS

The enforcement of the food and drugs act each year calls for new and improved methods of analysis and examination to keep abreast of the new forms of adulteration which appear from time to time and to make it possible more efficiently to carry out the terms of the law. During the past fiscal year particular attention was given in the laboratory to the following products.

CEREAL PRODUCTS

Comparative analyses of farina and semolina indicated that farina has a higher water-soluble-nitrogen content precipitable by 40 per cent alcohol and lower ash, lipoid, and protein contents than semolina. Ratios of lipoids, ash, and protein to water-soluble nitrogen precipitable by 40 per cent alcohol may be of value in differentiating between the two products.

Increasing the "prepanary" fermentation period of strong gluten doughs, containing 3 per cent yeast and 3 per cent sugar, from one hour to one and three-fourths hours produced loaves having more elastic crumb, and in other respects equal to, if not superior to, those made with the shorter fermentation time.

Baking tests were made with different flours using a "fixed type" of procedure in which, with the exception of absorption, the flours were the only variables. The same flours were also baked using the ordinary procedure in which the formula is about the only constant. The former method showed more strikingly the baking qualities of the flours.

It was demonstrated that if raisins are first soaked in malt extract they will not char when exposed to the direct heat of the oven in baking a raisin loaf. This practice is used by commercial bakers.

In the analyses of whole wheat and graham flours certain data to be used in differentiating between wheat meal and a scalped product were obtained. The ratios of $\frac{\text{starch}}{\text{bran}}$ and $\frac{\text{CaO}}{\text{MgO}}$ seemed to indicate differences that might be considered diagnostic.

Commercial rye flours from Washington (D. C.) bakeries contained approximately the same amount of moisture as wheat flour.

A note on the influence of peptic digestion in the determination of total carbohydrates in cereal products was published in the Journal of the Association of Official Agricultural Chemists, volume 9, page 482 (November 15, 1926). It was found that permitting pepsin to act upon cereals prior to treatment with diastase greatly facilitates the conversion of starch.

The investigation of malted milk showed that no lipolysis occurs when a malt-flour infusion is permitted to act on neutral butterfat or dried whole milk. It was concluded also that with proper control of conditions with respect to temperature and hydrogen-ion concentration, a malt-flour infusion will cause digestion of milk protein. Regarding the preparation of malt-flour infusion itself, it was shown that: (1) A malt-flour infusion prepared at 65° C. has a hydrogen-ion concentration of about 5.7 and an acidity as lactic of approximately 0.14 per cent; (2) the mashing temperature does not materially affect the hydrogen-ion concentration; (3) the highest sugar degree is obtained at 55°; (4) the temperature of 55° does not permit of complete starch conversion in four hours, although by increasing it to 65° C. for one hour a maximum sugar degree is yielded.

CHEESE

The study of the effect of aging of cheese on the fat constants was completed. The results showed that the Reichert-Meissl number of the fat of Italian Pecorino cheese was lower and the Polenske number higher than those of the fat of cows' milk cheese and that aging produced a lowering of the Reichert-Meissl number. The Reichert-Meissl number of the fat of Roquefort cheese made from goats' milk was found to be abnormally low and the Polenske number higher as compared with the Reichert-Meissl and Polenske numbers of the fat from the goats' milk itself, but very little change took place upon aging with respect to these fat constants.

Satisfactory methods for the determination of added citric and tartaric acids as emulsifiers in process cheese were outlined.

JELLY ROLLS

Experiments on the use of pure jellies in making jelly rolls demonstrated that the so-called "bakers imitation jellies" are not necessary in the manufacture of that product.

SEA FOOD

During the last year the possibility was studied of determining accurately small quantities of acetic acid that might be present in canned marine products by distilling with xylene under vacuum from liquor acidified with phosphoric acid. This method did not prove as satisfactory as the less complicated methods in common use.

CANNED GOODS

Experiments on a pack of blanched and of unblanched string beans showed that in some cases it is possible to get a full can when using unblanched beans. This work, taken in connection with that previously done on unblanched beans, indicates that some unblanched beans will increase in cut-out weight over put-in, and that others will decrease, owing probably to differences in maturity, growing conditions, or variety.

Experiments to determine the effect of freezing and thawing on canned peas showed that, after being frozen, the skin of the peas is much tougher than the skin of the peas in similar cans held at room temperature. No other effects were noted in these experiments, which were, however, too limited to permit final conclusions.

CACAO PRODUCTS

A method for the estimation of milk protein in milk cacao products was devised and published in Industrial and Engineering Chemistry, volume 19, page 501 (April, 1927). Incidental to this study, a paper on the determination of casein in milk was published in the Journal of the Association of Official Agricultural Chemists, volume 10, page 259 (May, 1927).

FRUIT ACIDS

A paper on the application of the Stahre reaction to the accurate determination of citric acid published in the Journal of the Association of Official Agricultural Chemists, volume 10, page 264 (May 15, 1927), sets forth the conditions required for obtaining maximum yields of pentabrom acetone from citric acid. It shows that under proper conditions as little as 4.5 milligrams of citric acid in the aliquot under examination yields acceptable results.

The further study of methods for the determination of fruit acids disclosed the fact that for very small quantities of tartaric acid (5 milligrams) the Kling method is not always reliable. It is believed that for determining such small quantities, the second precipitation should stand overnight in order to complete the reaction. Determinations of malic acid by the official method (Dunbar-Bacon procedure) are not satisfactory for small quantities of the acid and work for perfecting the method is now under way.

BEVERAGE AND FLAVOR INVESTIGATIONS

Because of the enormous increase in the distribution of bottled cocoa and cocoa-milk beverages preserved with hydrogen peroxide, accurate and dependable methods for the determination of minute quantities of this chemical in such food products have been worked out and described to State officials and its efficiency as a preservative in such beverages investigated. Federal and many State officials hold that hydrogen peroxide is not a proper ingredient of beverages. Hydrogen peroxide persists for a long time in such beverages and prevents bacterial activity as long as determinable quantities remain. The results of these studies are reported in two papers, entitled "Persistence of hydrogen peroxide in cocoa-milk beverages" and "Efficiency of hydrogen peroxide in preserving cocoa-milk beverages," to be printed in a trade journal. Through the studies on cocoa-milk beverages it was found that the powdered milk used was a serious source of contamination of the beverage. Consequently, samples of powdered milk from 39 manufacturers throughout the country have been procured and examined. The bacterial content of these samples varied from a few hundred to millions per gram. The organisms included nonspore-forming bacteria, resistant spores, and yeasts.

Manufacturers of imitation-maple flavors maintain that their products are not imitations because no one has ever manufactured genuine maple flavor. To show that such a flavor can be made, a laboratory process was developed for concentrating the flavor in maple sap or maple sirup to such a

degree that when from 2 to 4 ounces of it is added to a gallon of sugar sirup of suitable density a reconstituted maple sirup is produced which has the same composition and properties as ordinary maple sirup. A public service patent for a flavor to be manufactured by this process from maple sap, maple sirup, or maple sugar has been applied for.

The practice of adding imitation maple flavor to figs has been uncovered. Suitable action to correct this practice, or to insure proper labeling, is under way.

Samples of known origin of Michigan cherry juices and cherries have been analyzed and the results sent to the field force of the bureau and to State officials, as an aid in interpreting the results obtained in the examination of commercial samples of cherry products alleged to contain cherry juice.

The examination of 60 barrels of "cold-pack" strawberries and 25 barrels of "cold-pack" cherries was completed. The content of fruit juice in the samples was accurately determined by obtaining refractive indices of the fresh fruits and of the fruit sirups after storage. The results were sent to Federal and State food officials throughout the country.

Commercial drug products alleged to be radioactive reach the laboratory in many different states of physical condition, some as ores, some as clear liquids and opalescent liquids, and others as pills, pastes, etc. Methods for preparing these various kinds of samples for analysis of radium content have been developed and reported for publication.

DRUG-CONTROL INVESTIGATIONS

In cooperation with the Bureau of Home Economics, an extensive survey of cod-liver oils and cod-liver oil preparations found on the market was undertaken. Many products purporting to contain, in concentrated form, the active principles of cod-liver oil are offered for sale. Nearly all such preparations examined were either nearly or entirely lacking in vitamins. The truthful labeling of such products, not only as to composition but as to therapeutic representations, has received attention. Most of the oils so far examined, both domestic and imported, have been found to be of good quality. A close check is being maintained on imported cod-liver oils, for both human and animal use.

Results of a number of investigations on drug methods were published. These include researches on automatic devices for extracting plant material, the detection of diethyphthalate (an alcohol denaturant) in drug products, errors in the determination of alkaloids in the presence of soaps, suitability of chloroform for extracting alkaloids, the extraction of santonin in santonica, the stability of various alkaloids, such as atropine and hyoscyamine, during analysis, and methods for the examination of ipecac. Methods of examination of ginger and its various preparations, based on a study of its constituents, have been developed, also methods for determining cinchophen and podophyllum.

PHARMACOLOGICAL INVESTIGATIONS

The official bioassay standards specified in United States Pharmacopœia, X, were distributed to 21 firms and analysts in this country and to official investigators in England, Canada, Belgium, and Spain. During the year 65 samples of drugs and 106 importations of crude ergot were assayed. Two articles upon the assay of ergot were published. It was found that samples of crude ergot coming directly from Spain or Portugal were usually as strong as, or stronger than, the physiological requirements outlined in the Pharmacopœia, whereas those from Russia were usually below this standard physiological activity.

Experiments with the method of assaying mydriatics developed in the bureau have been extended to cover other mydriatics. The method has also been adapted to the quantitative assay of miotics. Information is now available upon atropine, hyoscyamine, hyoscine, homatropine, cocaine, pilocarpine, and physostigmine.

In connection with a case brought under the Federal food and drugs act, apples were seized on the ground that they contained excessive spray residue. Chemical analysis showed the presence of 0.05 grain of arsenic per pound, which corresponds to 0.25 grain of lead arsenate per pound. Peelings of these apples were fed to rabbits over a period of about seven days, after which the rabbits were killed and their tissues examined. Marked hyperemia and submucosal hemorrhages in the stomach walls, and congestion of the cortical and medullary layers of the kidneys were produced. Arsenic was found throughout the body; lead was localized in the bones. This case was

tried before a judge and jury, and verdict returned for the Government.

Experiments in which di-lead arsenate was fed to rabbits brought out the interesting fact that lead and arsenic may be transmitted through the mother's milk to nurslings.

An article on so-called habituation to arsenic, published in the Journal of Pharmacology and Experimental Therapeutics (vol. 28, p. 351, September, 1926), gives the results of a series of experiments which showed that there is no probability that any noteworthy systemic or gastrointestinal habituation to arsenic will be developed.

The study of the effects on health of food contaminated with tin was continued. Pumpkin and asparagus containing varying quantities of dissolved tin were fed to a "poison squad" of volunteers from the Bureau of Chemistry. Only small quantities of tin, or none, were found in the urines voided during the experimental period.

The histological examination of tissues of animals fed sulphur dioxide indicates that large doses cause definite injury and that small doses may cause some damage.

From the studies conducted this year it appears that the minimum lethal dose of gossypol, injected intraperitoneally into rats, is 25 milligrams per kilogram for acute death and 15 milligrams per kilogram for chronic toxicity.

The results of a three-year series of collaborative experiments with the Bureau of Biological Survey on the production of red-squill powders for use as rat poisons have been prepared for publication. This work suggests that white squill is not toxic to rats but that red squill is. The most toxic red-squill powders are usually those that have been dried at 80° C. Death from red squill is due to selective central respiratory paralysis. After extensive independent commercial study, a manufacturer in Ohio is now equipped to use about 1 ton of squill bulbs a day in the preparation of rat poison.

The use of thallium to eradicate various rodents, such as Zuni prairie dogs, coyotes, and porcupines is increasing. As the minimum lethal dose of this substance to white rats has been found to be 25 milligrams per kilogram, the possible danger to human beings in its use has been pointed out. It is as toxic as strychnine, and from five to ten times as toxic as arsenious oxide when employed as a rat poison.

In collaboration with the Bureau of Biological Survey, some 20 substances that were believed to be of value as attractants or repellents to rats have been tested. Naphthalene was the only one which offered much hope. The work indicated that there is a possibility of developing a commercially feasible rat repellent containing naphthalene.

MICROBIOLOGICAL INVESTIGATIONS

To detect spoilage and to develop effective means of preserving foods bacteriological studies must be made. Special attention was given to canned goods, cheese, and fish.

CANNED FOODS

Because of difficulties in interpreting the bacteriological cause of spoilage in many samples of canned foods examined in the laboratory, a field laboratory was set up where bacteriological experiments were conducted with a view to ascertaining the types of organisms responsible for decomposition. During the summer string beans, corn, and Lima beans were studied throughout the entire process of canning. The results on string beans showed that the most important source of organisms was the raw bean as it came from the field. Beans growing on the upper portions of the vine contained more organisms than those growing next to or on the soil. From 500,000 to 3,000,000 organisms were found on the lower parts of the vine and approximately twice as many organisms were present on beans from the upper portions of the same vine.

Experimental packs of string beans, corn, and Lima beans were put up during the canning season with a view to causing flat sour decomposition under varying conditions. Examination of these goods has shown that the only typical flat sours produced were from cans held eight hours in the sealed cans before processing.

PREVENTION OF SUGAR DETERIORATION

The proposal to use certain volatile substances to prevent the deterioration of raw sugar was investigated. It was found that formaldehyde, acetone, chloroform, and carbon bisulphide destroyed the mold inoculated into the sugar under the experimental

conditions, and that toluene and carbon tetrachloride failed to kill fungi. This indicates the possibility of preventing sugar deterioration under certain conditions by such means.

CHEESE STARTER

A striking example of the increased activity of a microorganism growing in close association with another species was found in the cheese starter used in the manufacture of Swiss cheese in certain regions. This consisted of a mycoderma associated with *Lactobacillus bulgaricus*. Investigation of the relation between these organisms showed that the acid production of the *L. bulgaricus* was approximately doubled by its association with the mycoderma. This mycoderma appears to be identical with Dombrowski's *Mycoderma lactis* alpha used in Finland for the manufacture of various milk products.

FISH

A large number of bacterial cultures from Scotch cured herring and other salted and preserved fish products were studied in pure culture with a view to identification. In the Scandinavian canned-fish products, which are sealed in cans without processing, the bacterial flora uniformly consists of streptococci, lactobacilli, aerobic spore-forming bacilli, and anaerobic spore-forming bacilli of the putrefactive type. The significance of these organisms has not yet been determined. The bacterial flora of Alaskan and Scotch salt herring consists of a multiplicity of forms, with aerobic and anaerobic spore-forming bacilli and streptococci predominating. The cultural reactions of a large number of these organisms have been studied, but, so far, no information has been obtained regarding the significance of any particular group. Whether or not any of these bacterial groups play a part in the normal curing or in the spoilage of this product can be determined only by the preparation of experimental packs in the field. The work on this problem has now reached the point where field work is indicated.

Some study has been made of the kind of culture media best suited for use in this work. Of particular interest is a group of so-called halophilic bacteria which are constantly present in the brine of Scotch and Alaskan salt herring. These organisms will grow only in the presence of at least 5 per cent salt and have been found to grow readily in the media containing 20 per cent salt. Following a study of the cultural reactions usually considered for the identification of an organism, an attempt was made to substitute for sodium chloride other chlorides and other sodium salts. Regardless of the reaction of these media and regardless of whether the salt added was computed on the molecular basis or on a percentage basis, growth of the halophilic bacteria occurred only on media containing sodium chloride, sodium sulphate, or sodium acetate, although very slight growth occurred on media containing lithium chloride. The reason for the support of such growth by sodium chloride, sodium acetate, and sodium sulphate, but not by the other salts used, is obscure. There is some indication that the sodium ion is necessary for growth of these bacteria, but that it must be in combination with some anion which is not antagonistic to the growth of microorganisms.

FOOD POISONING

Most of the samples of food suspected of causing food poisoning submitted during the year proved negative. These included bran, olives, home-canned string beans, and miscellaneous food products charged with causing enteric outbreaks. In one case the organism of dysentery was found. In a cheese-poisoning case the streptococcus previously reported as a cause of food poisoning was again isolated.

REDUCING SUGAR IN FRUIT JUICES

The possibility of reducing the sugar in fruit juices by the use of properly selected microorganisms was studied. Out of some 150 organisms several were selected as being capable of reducing all the sugar, under properly controlled conditions for growth.

MICROCHEMICAL INVESTIGATIONS

Microchemical methods of examination can sometimes be used more effectively than straight chemical methods in detecting adulteration and misbranding of foods and drugs. Often such methods are invaluable as supplements to the chemical methods. Since the passage of the food and drugs act many microchemical methods have been perfected in the bureau and the standards of comparison for

many products drawn up. The following received special attention during the fiscal year just ended.

CACAO PRODUCTS

Methods for making authentic cacao-product standards were described. The standard chocolate liquor containing 6 per cent of cacao shell was studied critically and the size of shell fragments in 25 samples of commercial cacao products was determined. Tests made with the euscope, suggested as a possible improvement upon the direct-vision microscope for determining shell, led to the conclusion that results by the direct-vision method are more reliable. The claim that a factor derived from standards containing small quantities of cacao shell would be higher than a factor derived from 100 per cent shell was disproved.

HONEY

The pollen content of various honeys was studied in an effort to determine, by means of count, a numerical expression for the proportion of the different kinds of pollen present. Results indicate that in many of the honeys named primarily on the basis of color, consistence, and flavor the proportions of the different kinds of pollen vary widely. One sample of a honey found to be poisonous contained a small quantity of Ericaceous pollen. Honey from the nectar of Ericaceous plants has long been regarded as poisonous.

DRUGS

The extent to which glandular materials are being exploited calls for improved methods for their microscopical detection and identification. Progress has been made on this difficult problem in animal histology.

FEEDING STUFFS

What are the smallest percentages of ingredients of feeding stuffs that can be detected by microscopical examination? To answer this question, mixtures of wheat middlings, linseed meal, and alfalfa meal in various proportions were examined. It was found that capable analysts can detect these products in 1 per cent quantities.

COOPERATION WITH STATE AND CITY OFFICIALS

At the close of the fiscal year the Department of Agriculture was cooperating with each of the 48 States in the enforcement of at least one act. All but one of the States have food laws comparable to the Federal food and drugs act. In two or three States the existing laws are not enforced, owing either to lack of appropriations or to the inadequacy of their provisions.

The Federal department has extended its contacts to departments that enforce laws on dairy products and commercial feeding stuffs. The opportunity for contact with State officials has been increased by the enactment of a model dairy law in New Mexico, by citrus-fruit legislation in Texas, and by numerous State acts dealing with the labeling of dangerous poisons for household use, similar to the law passed by the last session of Congress covering interstate shipments and assigned for enforcement to this department.

The year just passed has demonstrated perhaps more clearly than any preceding year the value of cooperation with State officials. The department has been called on to face some situations of peculiar difficulty, such as the control of canneries and cannery products and the control of shell eggs. It would have been impossible for the department alone to have coped with these situations as satisfactorily as was the case, particularly in the large egg-producing States and in those States where the canning industry is extensive. The fact that the services of State and city departments are frequently given without any possibility of recompense from this department in a material way is a tribute to the character of the men who are in official positions and an evidence of their whole-hearted acceptance of the cardinal principles of coordinated efforts.

TEA ACT

Table 3 shows the kinds and quantities of tea passed and rejected during the fiscal year ending June 30, 1927. All of the tea rejected, which amounted to 0.1 per cent, was rejected because it fell below the Government standard established under the tea act of March 2, 1897, in quality. During the last fiscal year no teas were rejected for being substandard in purity.

TABLE 3.—*Kinds and quantities of tea passed and rejected during the fiscal year ended June 30, 1927*

Variety or port of entry	Examined	Passed	Rejected for quality
	Pounds	*Pounds*	*Pounds*
Formosa Oolong	9,792,293	9,792,243	50
Foochow Oolong	29,564	29,564	
Congou	2,605,857	2,605,807	50
India	19,355,784	19,288,720	67,064
Ceylon	25,255,879	25,245,374	10,505
Blended Ceylon and India	600,439	600,439	
Java	9,054,747	9,051,416	3,331
Sumatra	868,792	868,792	
Ceylon Green	330,206	330,206	
Ping Suey Green	8,306,149	8,301,449	4,700
Country Green	960,124	960,124	
Japan	17,091,294	17,091,118	176
Japan Dust	1,817,896	1,817,895	
Capers	669	669	
Scented Orange Pekoe	23,262	23,262	
Scented Canton	580,443	580,443	
Canton Oolong	274,566	259,734	14,832
Jasmine	12,885	12,885	
India Green	628,668	628,668	
African	5,882	5,882	
Formosa Black	180	180	
Total	97,595,579	97,494,871	100,708
Boston	19,701,406	19,697,489	3,917
Chicago (9 months)	2,306,941	2,306,941	
Honolulu	342,075	342,075	
Puget Sound	11,817,192	11,816,942	250
New York	53,074,737	52,991,334	83,403
San Francisco	10,353,228	10,340,090	13,138
Total	97,595,579	97,494,871	100,708

The importations of the fiscal year fell below those of the preceding year by nearly 1,000,000 pounds. During the last fiscal year the importation of Congou tea was less by about 4,000,000 pounds than it was during the preceding fiscal year. This severe falling off in the black-tea importations from China is no doubt due to the civil war in that country, as many of the best black-tea districts are in the territory over which the northern and southern Chinese armies are fighting. The importations of India black teas during the year increased by more than 2,700,000 pounds over those of the preceding year. This increase no doubt was brought about by the extensive advertising campaign now being conducted by the Indian Tea Association in this country. This campaign is also probably the cause of the doubling of the quantity of India green tea imported during the year. As compared with the preceding fiscal year, there has been a falling off in the importation of Japan green teas to the extent of nearly 2,000,000 pounds, but this has been more than taken care of by an increased importation of over 3,000,000 pounds of Ping Suey green teas from China.

The general shifting during many years from a green-tea drinking nation to a black-tea drinking nation suddenly stopped this year—that is, if the kind of tea imported is a true index of what is consumed. The importation of green tea increased about 2 per cent and that of black tea decreased about 2 per cent, whereas the importation of semifermented or oolong tea about held its own.

The Boston station examined approximately 20 per cent of the total quantity, which is about 2 per cent more of the total amount than was examined in 1926. New York examined about 1 per cent less than in 1926, and the Puget Sound and San Francisco stations examined practically the same quantity as during the preceding year. On April 1, 1927, the office of the tea examiner at Chicago was discontinued because of the falling off in examinations there. All samples formerly examined in Chicago are now sent to Boston, which probably accounts for the increase in examinations at that port.

Only about one-tenth of the total quantity of teas rejected by the tea examiners were appealed to the tea board and only one protest, amounting to 4,700 pounds, was sustained. In the case of the other appeals taken from the findings of the tea examiners the importers were overruled.

INVESTIGATION OF TYPES OF TEA CONTAINERS

Tea packers and tea-container manufacturers, with whom the bureau has been cooperating in the investigation, continue to be actively interested in the study of the effects of different types of containers on the keeping of tea, and indirectly other food products, begun in September, 1925.

Although no results have yet been made public, it has been possible to give packers of tea and other food products information to meet their special needs. The investigation as a whole will probably be completed during the fall of 1927, when the results will be made public.

NAVAL STORES ACT

ENFORCEMENT

During the year inspectors operating under the naval stores act collected 133 formal and 57 informal samples

of turpentine and 16 formal and 28 informal samples of mineral spirits that were thought to have been advertised or sold in violation of the law. In only one instance was there an apparent disposition to continue this violation once it had been brought to the attention of the offending shippers. Steps have been taken to prosecute the concern involved. Apparently the sale of turpentine adulterated with mineral oil has decreased greatly in the territory covered by the bureau's naval-stores-inspection force. Through the efforts of the bureau also the use of steam-distilled wood turpentine for adulterating gum turpentine seems to have been discontinued. The fraudulent practice of reselling turpentine in original barrels on the basis of the gross gauged capacity of the barrel without allowance for the "outage" has been combated.

Formal samples from 25 lots of misgraded rosin were examined. In addition, approximately 3,000 barrels of rosin, representing 161 lots covering shipments of some 20,000 barrels to the larger north-central and eastern consuming points, were sampled and graded at distributing yards and consumers' plants. Only two citations were issued on account of serious misgrading, most of the grading being done within the limit of allowable error. These results indicate that the bureau's efforts to convince rosin producers and inspectors of the need for greater care and accuracy in grading have borne fruit.

Turpentine prepared as a by-product in the sulphate process of manufacturing paper pulp has a distinct, and sometimes disagreeable, odor. As the production and importation of this turpentine is increasing, and as no provision was made for it under the naval stores act, a hearing to consider a standard for "sulphate wood turpentine" has been called by the Secretary of Agriculture. This product is sometimes sold as steam-distilled wood turpentine, but is quite distinct from it.

SERVICE

Under the service features of the naval stores act, 32 samples of turpentine were analyzed upon request. Government certificates of analysis were issued on 14 of these samples, as they were the only ones taken directly from the original containers by Federal inspectors. The department has furnished regular rosin-inspection service to naval-stores producers in Mississippi, Louisiana, and Texas.

During the year, 105,742 barrels of rosin were graded by department inspectors, 103,214 barrels at the turpentine stills in Louisiana, Mississippi, and Texas, and 2,528 barrels in northern consuming centers. It is estimated that under the regulatory and service features of the naval stores act combined, the department's representatives have graded or checked the grading of close to 8 per cent of all the rosin produced in the United States.

SESQUICENTENNIAL EXPOSITION

In connection with the participation of the department in the Sesquicentennial Exposition at Philadelphia the Bureau of Chemistry installed an exhibit which illustrated various phases of its research and regulatory activities. This exhibit was beneficial both in bringing the work of the bureau to the attention of the public and in establishing new agricultural and industrial contacts. A gold medal and diploma were awarded to the bureau by the exposition authorities for the various exhibits which it installed.

PUBLICATIONS ISSUED

The following publications were issued during the year: Report of the Chief of the Bureau of Chemistry for 1926; 18 Service and Regulatory Announcement Supplements, containing 900 Notices of Judgment (Nos. 14101 to 15000); 14 Food Inspection Decisions—No. 198, Wine Vinegar, Grape Vinegar, and Malt Vinegar; No. 199, Gluten Flour, Self-Raising, "Diabetic" Food, and Canned Pea Grades; No. 200, Milk and its Products; No. 201, Glucose, Mixing Glucose, Confectioner's Glucose; No. 202, Dutch Process Chocolate (Alkalized Chocolate) and Dutch Process Cocoa (Alkalized Cocoa); No. 203, Fruits and Vegetables; No. 204, Flour; No. 205, Meats and the Principal Meat Products; No. 206, Alimentary Pastes; No. 207, Sweetened Condensed Milk; No. 208, Rice; No. 209, Colors in Food; No. 210, Cultured Buttermilk; and No. 211, Adulteration of Oysters; Miscellaneous Circular No. 22, Supplement 3, Amendment to Regulations for the Enforcement of the Naval Stores Act; Department Bulletin No. 1475, Production and Utilization of Fats, Fatty Oils, and Waxes in the United States; Farmers'

Bulletin No. 1523, Leather Shoes, Selection and Care; 2 articles in the Journal of Agricultural Research—Toxicity of Dipyridyls and Certain Other Organic Compounds as Contact Insecticides; and Relation of Size of Oil Drops to Toxicity of Petroleum-Oil Emulsions to Aphids; and 123 articles in various trade and scientific journals. In addition the following short circulars were mimeographed for a limited distribution: Fast Green F C F; Investigations on Spices; Information Sheet on Feeds and Feeding Stuffs; Candy-making Bibliography; Chloropicrin Bibliography.

U. S. GOVERNMENT PRINTING OFFICE: 1927

REPORT OF THE CHIEF OF THE BUREAU OF DAIRY INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF DAIRY INDUSTRY,
Washington, D. C., August 13, 1927.

SIR: I have the honor to submit herewith a report of the work of the Bureau of Dairy Industry for the fiscal year ended June 30, 1927.

Respectfully,

C. W. LARSON,
Chief of Bureau.

Hon. W. M. JARDINE,
Secretary of Agriculture.

The Bureau of Dairy Industry during the year has continued its research in milk production, dairy sanitation, and the manufacture of milk products and by-products. Slightly less funds were available than last year. Nevertheless, through rearrangement of activities and decrease of some service work, the research has been somewhat enlarged, and a satisfactory record of accomplishment has been made.

BETTER COWS NEEDED

As indicated in a previous report, it is believed that the most important need in the dairy industry to-day is to increase the efficiency of the average cow. The studies of this bureau have shown that the quantity of production per cow is the most important factor in economy of production.

On January 1, 1927, there were in this country 837 groups of about 25 farmers each in dairy herd-improvement associations. Since that time the number has increased to about 900 associations. Each of these groups employs a trained man to make the necessary tests and weighings every month in order to determine accurately the profitableness of each animal in each herd. Of the 22,000,000 dairy cows in the United States, nearly 400,000 are now in these associations, and the average production of these cows is about 7,500 pounds of milk a year. The records of these cows are available for study and provide an excellent basis from which the production situation in the country and the possibilities and opportunities for improvement can be determined.

The 360,000 cows in these associations during 1926 produced as much milk as 584,000 average cows and returned as much income over cost of feed as 640,000 average cows.

High-producing cows are economical in the use of feed. A tabulation of more than 100,000 individual cow records shows that cows producing 9,000 pounds of milk per year did not eat twice as much as cows producing 4,500 pounds, which is the average production of the cows of the United States. Instead, they ate approximately 40 per cent more in dollars' worth of feed per cow to produce twice as much milk and butterfat.

From the standpoint of economy of production, therefore, it seems clear that the way to meet the increasing demand for milk is not through more cows but through better cows, better fed. The average annual production of the cows in herd-improvement associations has increased from a little more than 6,000 pounds of milk in 1920 to about 7,500 pounds in 1926, which is an annual increase of more than 200 pounds per cow. When it is realized that the cows in herd-improvement associations to-day are producing 65 per cent more milk than

the average cows of this country despite the fact that it is more difficult to increase production as higher levels are reached, it is entirely reasonable to expect that the production of all the dairy cows could be increased at the rate of 200 pounds per year for many years to come. If the increase were to be only half as much—that is, if the average production of the cows could be increased 100 pounds of milk a year—an additional 2,000,000 people could be supplied each year for the next 40 years with the present per capita consumption without requiring an increase in the number of cows. The average annual production would then be only 8,500 pounds per cow.

Investigations are important, therefore, in the breeding of dairy cattle in order to develop herds with higher producing ability, and in nutrition and management in order to utilize fully and most efficiently each animal's ability for high milk production. Progress along these lines, as shown in detail in this report, has been encouraging; and it is hoped that these studies will be enlarged.

MANY PROBLEMS UNDER INVESTIGATION

Two new projects in market-milk work have shown promise of considerable value. One of these is a study of the bacteriological condition of milk as it passes through city milk plants. The effect of each operation is determined, and after a sufficient number of plants have been investigated it is expected that methods will be developed by which contamination of milk through processing will be reduced to a minimum.

Bottle breakage in milk plants runs into millions of dollars, and another project has for its purpose the reduction of this loss. Already the study has indicated the chief points of breakage and the causes for such breakage.

Problems of wide variety have been under investigation in the laboratories. Many of these require years of research before definite conclusions can be reached. During the year, however, knowledge of manufacture of milk products and by-products has been materially increased through these studies. New information on the mechanism of oxidation of fats will be useful in explaining and avoiding deterioration of dairy products, particularly milk powder.

The problem of control of texture of Swiss cheese seems now to be near solution. Studies in physical and chemical changes in freezing ice cream are giving promise of fundamental importance. Concentrated sour skim milk, a new product developed in the laboratories, is now being manufactured in such great quantities as to play an important part in industry.

NEW FIELD STATION ESTABLISHED

The agricultural appropriation act for the fiscal year 1928 granted $25,000 for the establishment of a dairy and livestock experiment station at Mandan, N. Dak., pursuant to act approved July 3, 1926, authorizing the establishment of such a station. These funds became available on January 18, 1927, and the construction of necessary buildings was actually begun about May 1.

A tract of Government land, comprising approximately 120 acres, located about 4 miles from the United States Northern Great Plains field station of the Bureau of Plant Industry, will be used for the station proper. In addition 160 acres of pasture land are held under lease.

Splendid progress is being made and it is expected that practically all construction work will be completed during the present calendar year.

DAIRY RESEARCH LABORATORIES

L. A. Rogers, *in Charge*

MILK SECRETION AND NUTRITION OF DAIRY COWS

In the work of the past year it has been established that a cow giving over 40 pounds of milk daily may be kept in positive calcium balance on a simple ration provided the quality of the hay is sufficiently good. This work has given some indication of the relation which should exist between the calcium and the phosphorus of the ration and has shown that the calcium of alfalfa hay is more assimilable than that of clover hay of equal quality.

Additional evidence has been obtained on the source of the amino-acid, cystine, which is one of the important constituents of casein. It has been found that it occurs in the blood as the cystine-glutamic acid dipeptid, glutathione, which is taken out of the blood when it passes through the mammary gland. This has been separated in sufficiently large amounts to establish its identity, but in order to determine its exact composition an effort will be made to obtain glutathione and other sulphur compounds of the blood in relatively large quantities.

BACTERIOLOGY AND CHEMISTRY OF MILK

A comprehensive study of the proteolytic bacteria of milk is nearly completed, and the results will be ready for publication in the near future. This work, in addition to furnishing a logical basis for the classification of this group of bacteria, has supplied much new information on the sources from which bacteria may obtain their carbon and nitrogen.

Much information of a highly technical nature has been obtained in various studies on the factors which control and limit bacterial growth. Some of the conditions which cause the lactic fermentation to cease at a very definite point have been established, and some interesting observations have been made on the effect of different types of lactic bacteria on each other when grown in combination.

Further observations on the effect of surface tension on the growth of bacteria have developed fundamental facts of value. Incidentally this work has shown some of the sources of error in making plate counts of the bacteria in milk and the means by which they can be corrected. The investigations on the lactic bacteria have shown that in making concentrated buttermilk it is possible to increase materially the acidity and thus improve the physical appearance and the keeping quality.

It has long been known that bacteria growing in milk cause a reduction of the oxygen, and this has been utilized in the methylene blue test to estimate the bacterial condition of the milk.

A study has been started of the reduction potentials, measured electrometrically, produced in milk by different bacteria. Each of the bacterial species studied has its peculiar reduction curve. This work will be continued by using other species and by attempting to adapt reduction indicators to the more nearly accurate estimation of the bacterial content of the milk.

Some progress has been made in determining the conditions which stimulate spore formation in bacteria.

CONDENSED AND EVAPORATED MILK AND MILK POWDER

Improvement has been made in some of the chemical methods used in the evaporated-milk investigations, and accurate results have been obtained on the precipitation of calcium in the sterilization process. Intensive work is now under way to determine the part played by bacteria in influencing the temperature of coagulation in the sterilizer. An attempt has been made to prepare a modified milk at moderate cost, suitable for infant feeding under conditions where a satisfactory fresh milk is not available. This has included a concentrated sour milk which requires no sterilization. A supply of this milk has been furnished to a number of hospitals, but no definite reports have yet been received.

The effect of storage of a skim-milk powder on its ability to improve a loaf of bread has been studied, and some of the preliminary results on the effect of high temperatures on the baking quality of milk powders have been confirmed. Some promising preliminary results have been obtained in the problem of applying oxidation reduction indicators to the problem of fat oxidation.

ICE CREAM

In some of the earlier work on the physics of ice-cream making it was demonstrated that there is a basic viscosity which is not removed by continued agitation. The work this year has established some of the conditions which control this basic viscosity and its relation to overrun. The tendency to regain what may be called the structural viscosity as soon as the agitation ceases is evidently of importance in determining the quality of the finished product. This tendency is affected by the composition of the mix, particularly the gelatin content, which also has a direct relation to the basic viscosity.

CHEESE

In the cheese investigations the greatest amount of attention during the past year has been given to the problem of controlling the texture of Swiss cheese. The quality of this type of cheese, particularly when made with pure cultures, is sometimes injured by a dry or woody texture.

To study the relation of the acidity of the cheese to this condition a method has been devised for following electrometrically the rate of acid formation in the young cheese. It has been found that marked differences exist in the rate at which the hydrogen-ion concentration of the cheese increases. A correlation has been established between this rate and the nature of the starter, the amount of the starter, and the treatment of the curd in the making process. Sufficient prog-

ress has been made to justify the expectation that means of controlling this difficulty will be obtained in the near future.

An investigation has been made of an abnormal fermentation of a process cheese containing pimentos. The cause of the gas formation was determined, and methods were suggested by which the fermentation could be reduced but not entirely prevented.

BY-PRODUCTS

The limits of acidity of whey which can be used in a new method of separating lactose have been determined.

The nature of the precipitate which forms when acid whey is neutralized has been established. The original method by which a high yield of lactose and a soluble protein powder can be obtained has been simplified so that refrigeration is not essential. The process has been put into commercial operation to obtain the soluble proteins for a special purpose.

Attempts to utilize the soluble whey powder obtained as a by-product in the manufacture of lactose by this process, as a substitute for egg white, have been unsuccessful on account of the failure of the whey albumin to coagulate with heat in the same manner as egg albumin.

Cooperative work with the Bureau of Chemistry on the use of lactose in preventing the crystallization of hard candies showed that while the lactose had a tendency to prevent crystallization it increased the hygroscopic properties so that its use was impractical.

DAIRY-CATTLE BREEDING INVESTIGATIONS

R. R. GRAVES, *in Charge*

THE BELTSVILLE EXPERIMENTAL BREEDING HERD

In accordance with the plan of giving each female in the breeding projects an official record at 2 years of age and again at maturity, preferably at 5 or 6 years of age, 15 additional records were completed during the year. An effort is made in this test work to keep the environmental conditions each year as nearly uniform as possible. The animals are milked three times a day throughout the year, are kept in box stalls, and receive the same feeds during the entire year. The amount of feed consumed by each animal is carefully recorded. The production records thus made are considered as the maximum capacity of the animals under these conditions and are used in the breeding studies as a measure of inheritance for milk and butterfat production.

At the end of this fiscal year, at the Beltsville station, a total of 75 records have been made by 59 Jersey cows with an average yearly production of 9,792 pounds of milk and 5.5 per cent, or 540 pounds, of butterfat, and 71 records by 52 Holstein-Friesian cows with an average yearly production of 16,559 pounds of milk and 3.42 per cent, or 567 pounds, of butterfat. The yearly average for the 146 records of both breeds is 13,082 pounds of milk and 4.22 per cent, or 553 pounds, of butterfat. This is a daily average of 35.8 pounds of milk testing 4.22 per cent. The average age at which the records were started for both breeds was 3 years 10 months.

ABORTION REACTING ANIMALS IN THE HERD SEGREGATED

For a number of years progress in the breeding and nutritional investigations at Beltsville has been hindered by the presence of abortion in the herd.

The agglutination test for abortion has been applied to the herd for a number of years.[1] At first an attempt was made to control the disease by means of segregation at time of calving and by sanitation. It was felt that some progress was being made in checking the infection by this means, but in 1925 quite a number of pregnant heifers became infected and aborted. More definite measures were believed to be necessary in controlling the disease, and for this reason a set of temporary buildings in which to house the reacting animals was constructed about half a mile from the permanent barns. These new buildings were ready for occupancy in May, 1926. Most of the reacting herd was moved to the new quarters at that time, but because of certain experimental work a number of reacting animals in one barn were not moved until October, 1926, when the segregation of all positive reactors was completed. During the interval from May to October, 1926, 24 animals in

[1] The Bureau of Dairy Industry does not conduct investigations in abortion or other diseases. Such studies are carried on by the Bureau of Animal Industry, and the agglutination tests reported here were made by that bureau.

the negative herd became positive and were added to the reacting herd. Between October 1, 1926, and June 30, 1927, only two animals became positive reactors, and the last test showed no reactors in the negative herd. There are now 85 females in the positive herd and 120 females in the negative herd. The progress of the disease in the herd since 1921, as indicated by the reactions to the agglutination test, is shown in Table 1.

TABLE 1.—*Progress of abortion in Beltsville herd*

Year [1]	Total number females	Number new reactors	Percentage of total herd	Total number reactors
1921	113	-------	-------	45
1922	135	4	2.96	44
1923	129	19	14.72	58
1925	180	23	12.77	67
1926	185	36	19.48	89

[1] No test in 1924.

The breeding efficiency of the animals in the reacting herd and in the negative herd is determined by the percentage of animals of breeding age that became pregnant during the year. Of the 62 animals of breeding age in the negative herd 48 became pregnant, an average breeding efficiency of 77.41 per cent. Of the 100 animals in the reacting herd 63 became pregnant, an average breeding efficiency of 63 per cent. The average percentage of breeding efficiency of the grades, the Holstein-Friesians, and the Jerseys, in both herds was practically the same.

During the last fiscal year 102 pregnancies were terminated in the two herds. Of these, 64 were in the reacting herd and 38 in the clean herd. The 64 pregnancies in the reacting herd resulted in 31 living calves, or 48.4 per cent; 28 abortions, or 43.7 per cent; 1 mummified calf, or 1.6 per cent; and 4 calves born dead, or 6.2 per cent. The 38 pregnancies in the negative herd resulted in 30 living calves, or 78.9 per cent; 2 abortions, or 5.3 per cent; 2 mummified calves, or 5.3 per cent; and 4 calves born dead, or 10.5 per cent.

All animals in the Beltsville herd are examined after calving and again before breeding in order to determine whether any conditions exist that might prevent conception. The abnormal conditions found in both the positive and negative herds during the past year were as indicated in Table 2.

TABLE 2.—*Abnormal conditions of cows in Beltsville herd, 1927*

	Positive herd	Negative herd
	Number	*Number*
Corpus luteum (interfering with estrum)	38	18
Ovarian cysts	9	3
Inflammation of uterus	9	0
Inflammation of cervix	9	4
Persistent ovarian cysts (resisting all treatment)	2	1

FERTILITY STUDIES

Bull experiments are being conducted to determine the effect of certain nutritional régimes, exercises, and amount or frequency of service on the activity of the spermatozoa, their longevity, numbers, form, and structure. The herd sires at the farm are examined each month. A stained specimen of the semen is preserved from each examination. A number of bulls are being used in this investigation.

One bull has been carried through a series of experiments to determine the effect of sprouted oats in the ration, the effect of exercise, the effect of exercise and sprouted oats, and the effect of lack of exercise on the initial activity of the spermatozoa and their activity five hours later. The bull was kept under each phase of the experiment for a period of 90 days. At the end of each period he was allowed one service a day for six consecutive days and the semen for each service examined. The average of these six observations is given in Table 3.

TABLE 3.—*Effect of diet, exercise, and service upon spermatozoa of bulls*

	Estimated percentage of sperm cells showing activity immediately after service	Estimated percentage of sperm cells showing activity 5 hours after service
In box stall without exercise and on regular ration	60	45
In box stall without exercise but with sprouted oats added to ration	90	50
Exercised 1½ to 2 hours daily and fed sprouted oats	90	65
Exercised 1½ to 2 hours daily, regular ration. No sprouted oats	70	40
In box stall with no exercise and no sprouted oats	55	15

A considerable amount of variation was shown in the numbers of sperm cells in the second, third, and fourth periods, with quite a marked decline in numbers during the last period. This experiment will be repeated with other animals.

In the case of one bull, the effect of excessive service has been noted. On four successive days this bull was allowed four or five services. On the fifth day service was refused. The number of sperm cells declined as the experiment progressed. The structure of the cells also changed.

MAMMARY-GLAND STUDIES

A comparative study of the mammary gland through its different stages of development and activity has been carried on in the dairy herd. Post-mortem examination of the gross and minute structure of the udder has been included whenever possible.

The capacity of the secretory system of the gland is found to be greatly in excess of what it is commonly supposed to be. Last year a report was made of the measurement of the capacity of the secretory system of four udders filled with formalin pumped in through the teats. During the last year the capacity of 15 additional udders has been measured. A summary of the measurement of these 19 udders shows that the secretory system of each of seven cows, nonlactating or nearly so, accommodated an average volume of fluid equivalent to that of 25.81 pounds of milk, whereas the milk equivalent capacity of each of seven actively secreting udders averaged 49.82 pounds. One dry beef cow showed an udder capacity of 8.22 pounds, and the udders from four heifers and cows that were never pregnant showed an average of 7.68 pounds, ranging from 2.59 to 12.72 pounds.

Last year a report was made of the post-mortem milking of an amputated udder from a cow killed at the regular hour of milking. This work has been extended to six additional cows during the year. Combined results from the seven cows show that on the average 68.7 per cent of the quantity produced at similar milkings before death was obtained by post-mortem milking of the amputated udder. The post-mortem production ranged from a minimum of 40.3 per cent to a maximum of 101 per cent of the production before death. In the first four cases 61.1 per cent was obtained. In the three cases more recently handled the conditions were more carefully controlled, and 78.7 per cent was obtained.

The outstanding abnormality in the milk obtained from the amputated udder is a low butterfat test, which averaged approximately 55 per cent of the test of milk procured before death. Allowing the udder to become chilled after its removal from the body tends to lower the butterfat test still further.

COMPARISON OF CONFORMATION AND ANATOMY OF DAIRY AND BEEF ANIMALS

About three years ago Sophie 19th of Hood Farm, a purebred Jersey cow and a world's ex-champion butterfat producer, was presented to the bureau in order that her type and anatomy might be studied. In addition, her skeleton was preserved and mounted. Recently Blackbird of Dallas, a purebred Aberdeen Angus cow and a showring winner, was secured for similar study. Her skeleton also has been preserved and mounted. These two cows represent extremes of conformation. Their external form, internal anatomy, gross and minute structure, and skeletal form have been studied comparatively. The results are now being prepared for publication. The skeleton of a purebred Jersey bull is also being prepared and mounted.

RECORD STUDIES

According to results obtained from the analysis of official herd records of one breed of dairy cattle, 611 daughters, the progeny of 51 bulls, produced in one year an average of only 164 pounds more milk than their dams. This small increase in one generation does not indicate very rapid improvement. Further study of the data shows that the 10 best bulls sired 96 daughters which surpassed their dams by 1,226 pounds of milk as yearly producers. These figures point to the necessity for greater care in the selection of herd sires and emphasize the value of the proved sire for increasing average milk production. When the whole group of dams was divided into two lots, one above and one below average, the 51 sires failed by 1,531 pounds to maintain the level of production of the dams above the average, but they succeeded in raising the level of production of the dams below the average by 1,307 pounds. This type of selection on the female side alone would continue progressively upward

only by severely culling each generation to the point where the numbers could not be maintained. But when female selection was combined with choice of only the best bulls, the figures show that the 10 best bulls mated to cows above average were able to sire daughters as good as their dams, and from dams below average their daughters were 2,507 pounds better than the dams. Similar results are apparent from the analysis of the records of another breed.

INVESTIGATIONS ON GROWTH OF HEIFERS

The weights of Holstein heifers recorded for two years in the experimental herds at Beltsville, Md., and at Ardmore, S. Dak., together with the weights of Jersey heifers recorded at Beltsville and Holstein weights reported by one of the State experiment stations, have been the subject of statistical interpretation. In addition a study has been made of the variability of weight increase as revealed by Guernsey weights secured in a private herd where accurate records were kept.

MEASURING THE GAINS

In all cases the weights have been considered on the basic assumption that the normal growth of the dairy cow should resemble that of other organisms which have been investigated up to the present time, and therefore statistical methods of measuring the latter can be applied successfully to the weights of heifers.

The most successful method of measuring the gains has been accomplished by dividing the weights into three time groups—birth to 6 months, 6 to 17 months, and 17 to 24 months in the case of the Holsteins; and birth to 6 months, 6 to 16 months, and 16 to 24 months for the Jerseys. These three groups in general coincide, respectively, with the period of skim-milk feeding, the period following the removal of skim milk to pregnancy, and the period of pregnancy. By arranging the monthly weights in this way a series of cycles is presented, each cycle being broken off before its completion. Specific weight equations have been calculated for each set of weights.

The facts obtained indicate a need for extended nutritional tests to find out whether or not normal growth can be portrayed by a single cycle. This has a practical bearing on the feeding of skim milk. Maximum gain was observed at about 6 months of age, but there is some reason for believing that if the feeding of skim milk had been continued longer the maximum would have been delayed. Under a system of feeding in which skim milk is fed continuously, would the heifers gain in weight according to a single cycle or would the weights be split up into a series of cycles as at present? A beginning has already been made in the solution of this problem and evidence has accumulated indicating that by prolonging the feeding of skim milk greater weights can be obtained for at least several months beyond the initial six-month period.

HEIFER WEIGHTS AND THE CURVE OF AUTOCATALYSIS

The practicability of using the autocatalytic curve for measuring the gains made by heifers in the Bureau of Dairy Industry experimental herds has been investigated. The results are sufficient to justify the belief that there has been a tendency to disregard the effect of environmental changes, particularly those of a nutritional nature, in reports which have hitherto been made. Although growth may be cyclic in nature, at present it is impossible to distinguish in any of our data the complete cycles postulated by the autocatalytic theory.

VARIABILITY OF WEIGHTS

Variability of weight increase of heifers has been investigated. It was found that at birth the variation between individual weights and the average herd weight amounted to 15.6 per cent. Immediately following birth there was a tendency toward increased variability of growth. This variability reached a maximum of 22.4 per cent at 4 months of age and was very pronounced to the age of 6 months. During this period of extreme variability, which was coincident with the feeding of skim milk, an opportunity was provided for some heifers to become exceedingly large and others to remain exceedingly small.

Commencing with the seventh month the herd presented a growth condition, in so far as its uniformity was concerned, similar to that noted at birth. At the eighteenth month variability had reached a minimum of 10.4 per cent. Apparently the very large animals made little gain and the very light animals made comparatively rapid gains. The whole herd seemed to have become stabilized with respect to gains. This is proved by the fact

that approximately 68 per cent of the heifers varied from the average herd weight within only 75 pounds, the lowest variability observed during the two years considered. Whether this was due to pasture or to pregnancy is undetermined.

REGISTRATION RECORDS AND PROLIFICACY IN CATTLE

Registration records compiled by the breed associations have been used in studying prolificacy in cattle.

In one breed a study was made of the relationship between the number of progeny of 749 dams and of that of their daughters. In general, as the number of progeny of the dams increased there was an increase in the number of progeny of the daughters. When the dam's progeny were fewer than three, the number of the progeny of the daughters was greater than that of the dams, whereas when the dams had three or more offspring the number of progeny of the daughters was fewer than that of the dams. There is in this mass data a noticeable tendency for the race to become sterile, a fact which possibly would not be apparent if the number of offspring of daughters were correlated with the number of offspring of both their sires and dams. From a practical standpoint, this, of course, provides an argument for paying attention to the prolificacy behind both male and female ancestry when endeavoring to select for the character of high prolificacy.

In a study of the relationship between the number of the progeny of 572 dams and of the time between the births of their first and last calves, it was found that as the number of the progeny increased the ratio between the two variables concerned became greater. For example, when the dams had 3 offspring the latter were born within an average total interval of about 42 months. For 9 offspring the interval was about 122 months; for 12 offspring, 144 months; and for 14 offspring, 161 months. Apparently the cows which were kept the longest were the most efficient producers of calves from the standpoint of the time involved. This study indicates one of two things: Either there is a favorable relationship between age and breeding efficiency, or in the herds represented by the records the practice of culling inferior individuals early in their breeding life was responsible for the good results obtained from cows kept for a long breeding period.

FIELD STATIONS

In a grading-up experiment at the Ardmore, S. Dak., station several cows which were the result of the first cross of a Holstein sire on native cows have been bred to the purebred sires in the herd. These foundation cows had an average production of 202 pounds butterfat and an average lactation period of 238 days. The daughters produced 246 pounds butterfat in an average lactation period of 272 days, and the granddaughters produced 315 pounds butterfat in an average lactation period of 326 days. Two great-granddaughters have recently freshened. One already has produced 205 pounds butterfat in 189 days and the other 152 pounds butterfat in 99 days. The foundation cows had been raised under range conditions and were rather wild. They also seem to have inherited from their range mothers a dominant trait that tended to a short lactation period. This trait seemed to have been bred out in the granddaughters, which had an average lactation period of 326 days. The length of lactation period has been increased with each succeeding generation of Holstein-Friesian blood. Since the animals of each generation had the same environment in this experiment, the results would seem to indicate that persistency of production is controlled by inheritance.

A comparison of pastures of native grass, sweet clover, crested wheatgrass, and brome grass gave the following values based on the nutrients required for the cows while on pasture: Native grass, $4.48 per acre; sweet clover, $6.63; crested wheatgrass, $7.70; and brome grass, $6.75.

It has been found that when cows are exercised in a dry lot and fed home-grown grains, alfalfa hay, and corn silage, 9½ acres of land at Ardmore are required on the average to maintain for one year a cow producing 300 pounds of butterfat. When the cows are pastured, 12 to 15 acres are necessary for pasture and the growing of the other feeds.

Seventeen Holstein heifers that averaged 90 pounds at birth, 590 pounds at 1 year of age, and 973 pounds at 2 years, have been raised at an average feed cost of $31.54 for the first year and $35.05 for the second year, making a total of $66.59

for the two years when feeds were figured at local market prices.

At the Woodward, Okla., station pasture experiments have been conducted with Sudan grass, winter wheat, winter rye, and sweet clover. The results shown in Table 4 were obtained when the value of the pasture had been calculated in terms of the local market prices of the quantities of alfalfa hay and corn silage that would have been required to supply an equivalent amount of nutrients for the maintenance of body weight and for the milk produced while the cows were on pasture.

TABLE 4.—*Value of pastures of different kinds for cows, Woodward, Okla.*

Kind of pasture	Years averaged	Pasture season	Value per acre
Winter rye	3	Mar. 10 to May 25	$7.60
Winter wheat	2	Mar. 9 to May 22	8.76
Sweet clover	1	June 20 to Nov. 27	10.89
Sudan grass (drilled)	6	July 1 to Nov. 5	12.50

When the yield of total digestible nutrients per acre of such a crop as Sudan grass at the hay-cutting stage of maturity is compared with its yield when pastured, it is found that the yield is increased 140 per cent by allowing the crop to mature. However, the nutrients credited to the pasture were calculated from the milk yield of the cows on pasture, whereas the nutrients credited to the hay crops were obtained by using the average analyses given in Henry's "Feeds and Feeding" as applied to the average yields secured at Woodward. It is possible that the pasturing of immature crops under hot and dry weather conditions prevents them from reaching their maximum growth.

At the Huntley, Mont., station, irrigated pastures manured for eight years at the rate of 15 tons per acre had an average carrying capacity of 2.2 cows per acre for a pasture season of 138 days and an average pasture value of $61.85 per acre, the value for the eighth year being $70.47 per acre. Irrigated pastures not manured had a carrying capacity of 1.4 cows per acre and a pasture value of $32.56 per acre.

Data collected on 53 cows of all ages to determine the influence of pregnancy upon the gain in weight of the dam showed an average weight at time of service of 1,150 pounds; at time of calving, 1,435 pounds; and on the first day after calving, 1,280 pounds. When the dam weighed 1,500 pounds or less there was a marked relationship between the weight of the calf and the weight of the dam. For dams weighing more than 1,500 pounds this relationship did not exist.

Forty-five young bulls have been placed with dairy farmers in the vicinity of Huntley in order to prove their transmitting ability for milk and butterfat production. Ten of these have already been proved. The poorest bulls increased the average production of their daughters over that of the dams of the daughters by only 9 pounds of butterfat when the production of each was calculated to maturity. The best bull increased the production of his first six daughters to complete records by 174 pounds of butterfat over that of their dams.

At the New Iberia, La., station progress has been made in the breeding experiments in which an attempt is being made to breed dairy cattle that will be pure in their inheritance for high-producing ability. This experiment is being carried on by the continued use for generation after generation of sires that have shown by the uniform ability of their daughters that they are homozygous in their inheritance for the factors controlling high production. The fourth proved sire is now in use on the herd at this station.

Extensive experiments on management of pastures and carrying capacity of pastures were started this season. An experiment is also under way in the comparison of three planes of feeding, in which locally grown feeds for the most part are to be used. Unfortunately all these experiments have been interrupted by the flood, which has necessitated the removal of the dairy herd from the farm and has resulted in the probable destruction of crops and pastures for the greater part of this growing season.

A project in cooperation with the zoological division of the Bureau of Animal Industry is under way to determine the identity, extent, and control of an intestinal parasite that infests the pastures in this region. It is thought that this intestinal parasite has hindered the growth and development of the calves and possibly has resulted in the lactating cows being unable to approach their hereditary level of production.

MARKET-MILK INVESTIGATIONS

ERNEST KELLY, *in Charge*

DAIRY SANITATION

The study of the bacteriological condition of milk as it passes through city milk plants has been begun for the purpose of determining the greatest points of weakness from a sanitary standpoint in the average milk plant. Although some of these points are already known, there are little or no specific data covering a wide field in the industry. The work will be continued until enough plants have been surveyed to determine where the greatest points of bacterial increase are, the reasons for these, and means of preventing the increase of bacteria.

In these studies bacteriological examinations of the milk are made at each step in handling from the time it enters the plant until it reaches the storage room. Samples of the stored milk are also taken to determine what effect the storage methods and temperatures have had on the number of bacteria in the milk. These samples are collected on five successive days, thus assuring average conditions for each plant. Over 30 plants have been completely studied up to the present time. From the data secured it is believed that three operations contribute largely to increases in the bacterial counts. One of these is the passage of milk over the cooler; another is the passage of milk through the bottling machine; and the third is the storing of milk, during which time it is refrigerated in the bottle until delivery. It has been found that in the average milk plant the increase in bacterial count during each of these operations is practically the same; that is, each of the three operations contributes substantially in about the same degree to the bacterial count of the finished product as it is delivered to the consumer. At the first group of plants for which tabulations are completed, the following were the average counts:

	Per c. c.
Raw milk	9,265,000
Pasteurized milk in vat	24,100
Bottom of cooler	31,100
Bottle from filler	38,000
Same bottle after 24 hours storage	45,000

It can be seen that the bacterial count of the milk when it leaves the storage room is nearly double that of the milk when it comes from the Pasteurizer. A great deal of this recontamination and subsequent growth can be prevented. It is believed that simplified methods can be worked out whereby this can be done.

An interesting development of this work has been the study of temperatures maintained in cold-storage rooms. An automatic temperature recorder, together with several maximum and minimum thermometers, is being employed in the storage rooms of all plants studied. These are placed in different parts of the rooms and at various heights between the floor and ceiling. These thermographic records have shown a great variation in temperature in different parts of the rooms. By slightly altering systems of refrigeration and air circulation, it would be possible to maintain temperatures which would be more nearly uniform. As an example, temperature ranges in storage rooms having an average hourly temperature between 36° and 43° F. have shown daily variations between 30° and 62°. In other words, the same room has a variation of 32° in temperature during the storage period. This work is showing conclusively that too much faith has been placed in the average cold-storage room for the maintenance of proper temperatures for milk preservation and that sometimes large increases in bacterial counts have resulted from lack of knowledge on this point.

Work on the steam sterilizers for farm dairy utensils has been completed and additional data on cost and bacteriological efficiency of operation have been obtained. The bureau is now in a position to furnish dairy farmers with blue prints for the construction of the particular type of sterilizer which will meet their special needs and which can be constructed and operated at a minimum cost.

Fly eradication and control work in cooperation with the Bureau of Entomology have been continued at the Beltsville dairy. Similar work done in 1925 seemed to have had its effect, since the flies were not so numerous as in previous years. During the summer 62 gallons of flies were trapped, which is only 75 per cent of the quantity caught in 1925. Since the dairy was kept comparatively free from flies during the last year, the smaller quantity caught indicates that there were fewer flies present as a result of the previous work. Further preventive work was done by treating the ground upon which manure had been piled with hellebore solution, which was mixed at a cost of 1½ cents a gallon. Further studies were carried on to determine the optimum height of legs for the fly

traps, and it was found that if the traps were too low and came too close to the bait pans fewer flies were caught. Throughout the summer flies did not become numerous or bothersome, and the work of spraying and trapping was conducted easily and economically to obtain this result.

MILK-PLANT MANAGEMENT

Milk-plant work has consisted of a continuation of the milk-plant labor studies and a new project which involves the breakage of bottles in milk plants. Results already obtained show that very great savings can be made in the handling of milk by reducing bottle losses due to breakage in the plants.

Personal studies have been made in over 40 plants, and records on 35 of these have been tabulated and analyzed. At each plant studied at least one week is spent in the survey. Broken glass is collected at the various points throughout the plant, and at the end of each day's run this glass is weighed. At the 35 plants from which records have been tabulated the total breakage per 1,000 bottles filled varied from 4.1 to 28.1 pounds. It is obvious that a great deal of the high breakage can be reduced.

The annual cost for replacing milk bottles used in the United States is about $30,000,000. Of this amount over $12,000,000 results from breakage in the plants, and the work of this bureau indicates that at least half of this amount can be saved. For example, one plant which was studied had an unusually high breakage. If the breakage can be reduced to the average in the 35 plants, a large saving of bottles will result. Suggestions which this bureau has been able to make as a result of these studies have already had a considerable effect in reducing the breakage in individual plants.

The bottle-breakage work is not intended to show simply the amount of breakage but serves as a means of studying the points at which breakage occurs and the causes and character of the breakage. In each plant visited a floor sketch showing the arrangement and type of machinery is made, and from these studies, properly correlated with the breakage at various points, fundamental principles regarding the handling of bottles have been worked out. The data already obtained show that as a general rule breakage of quart bottles is relatively less than that of smaller bottles. In general, where bottles pass up and down to two or more floors there seems to be more breakage. Less breakage seems to occur where the newer types of bottle washers are used. The use of conveyors at the receiving platforms results in less breakage than trucking the bottles on hand trucks or dragging the cases with hooks.

MARKET MILK AND CREAM

FLAVOR AND ODOR

During the summer of 1926 and again in the late spring of 1927, observations were made on bitter milk coming from cows which had eaten bitter weed (*Helenium tenuifolium*). Experimental work was carried on in Mississippi, at Beltsville, Md., and in the laboratories in Washington, D. C.

Bitter weed, when eaten by dairy cows, gives such a bitter, astringent taste to milk that in many cases it can not be consumed. As bitter weed is abundant in large areas of the Southern States, especially during dry seasons when grass is short, losses from this cause are sometimes very great. The particular work done during the past year was to manufacture various dairy products in an attempt to evolve methods by which the bitter principle could be eliminated. Some of the bitter weed was dried and shipped from Mississippi to Beltsville, where it was fed to cows on the experimental farm. It was found that the bitter principle seemed to be in solution or in fine suspension in the water of the milk. Removal of practically all the fat, casein, albumin, and milk sugar still left the bitter principle in the serum. It was found possible to make butter which, when properly washed, was free from the bitter flavor. The buttermilk, however, was not usable for human food. Cottage cheese was made which, after being thoroughly washed, contained but a slight trace of the bitter flavor. Unsweetened evaporated milk, either skim or whole, contained the bitter flavor in an even more concentrated form than the original milk. Sweetened condensed milk contained a trace of the bitter flavor, but the added sucrose concealed the objectionable flavor to a great extent. It was also possible to extract crude milk sugar with scarcely a trace of the bitter flavor. After the extraction of the fat, casein, and sugar the albumin in the residue was precipitated with alcohol and

washed free from the bitter flavor. This operation showed that the albumin and the bitter principle are not associated and that the latter is soluble in alcohol. The alcohol was evaporated, and further experiments showed the bitter principle to be a separate element or compound. It is insoluble in petroleum ether, but soluble in alcohol, benzol, and ethyl ether. Tests with the residue from the benzol solvent showed that the bitter principle is neither a glucosid nor an alkaloid.

From the work of the bureau it appears that butter and cottage cheese may be made from bitter milk, provided that care is taken to wash them thoroughly. Furthermore, it is possible to make milk sugar from the skim milk or to make sweetened condensed milk of a fairly satisfactory character.

Further experiments were conducted on the effect of various feeds on the flavor and odor of milk. Thousandheaded kale and rape, when fed before milking, had a decidedly deleterious effect on the flavor and odor of the milk produced. These feeds could be fed immediately after milking, however, without injuring the flavor of milk drawn at the subsequent milking. In the work with green soy beans the flavor of the milk was not impaired; on the contrary, it seemed to be somewhat improved even when 30 pounds of the plant were fed one hour before milking.

VISCOSITY

Work has also been continued on the viscosity of cream with special reference to the size and appearance of fat globules. In the case of mixed milk from Jersey, Guernsey, and Holstein cows, 2,500 measurements of fat globules from raw cream testing 20 per cent butterfat have been made. The fat globules ranged in size from 1 to 11 microns in diameter, with an average of 3.34 microns. The effect of age on the appearance of the fat globules has been determined, especially in regard to the clumping. With raw cream testing 20 per cent butterfat it was found that there is practically no clumping of fat globules in 24 hours. At 48 hours there is very slight clumping, which increases up to 96 hours. Correlated with previous work of the bureau on viscosity, this shows that a close relationship exists between the clumping of fat globules and the viscosity. With raw cream testing 30 per cent butterfat the same correlation was found, but clumping was more rapid with the richer cream.

The effect of freezing on the viscosity of cream has been studied. The freezing of cream changes the physical structure, which will not revert to normal on thawing. In the case of raw cream testing 20 per cent butterfat it was found necessary to thaw the cream at a temperature only slightly higher than the melting point of butterfat. When the cream was thawed at a higher or lower temperature, the casein flaked to such an extent that it was impossible to make viscosity determinations. In the case of raw cream with a butterfat content of 30 per cent it has been impossible to prevent the butterfat from separating out when the cream was thawed. The viscosity of raw cream testing 20 per cent butterfat is decreased by freezing. Microscopic examinations seem to show that the freezing of cream prevents the clumping of the fat globules, which probably accounts for the difference in viscosity. Rapid cooling of cream from a temperature of 26° to 5° C. gave a poorer viscosity than when the cooling was carried on more slowly. It is believed, and microscopic examinations seem to confirm it, that rapid cooling congeals the fat globules so rapidly and to such an extent as to prevent their clumping.

FOAMING

Studies have been made of the effect of temperature, aging, Pasteurization, agitation, and percentage of butterfat upon the foaming of milk and cream. Experiments have shown that with skim milk, milk testing 3 per cent butterfat and milk testing 5 per cent butterfat the least amount of foam is developed at 20° to 30° C. Low temperatures give large amounts of a light, airy foam, whereas increased amounts of heavier foam occur at temperatures up to 90°. Cream testing 18 per cent butterfat gives the least amount of foam at 40°. Above and below that point the amount of foam increases as the temperature increases or decreases. The stability of foam has been determined by taking immediate readings and readings one minute later. The one-minute readings are lower in all cases than the immediate readings. As the temperature increases, the difference between these readings lessens.

Aging milk and cream for 24, 48, and 72 hours can not be considered a factor in the ability of milk and cream to foam, with the exception of

skim milk at temperatures of 5° and 10° C. At these temperatures the immediate readings show progressive increases for skim milk 24 and 48 hours old and then a decided falling off at 72 hours old.

At immediate readings raw skim milk produces more foam than the same milk after it has been Pasteurized for 30 minutes at 62.5° C. The reverse was found for one-minute readings. The same results were found for skim milk 24, 48, and 72 hours old. At immediate readings raw milk testing 3 per cent butterfat and raw milk testing 5 per cent produce more foam than the Pasteurized milk. One-minute readings are the same for both Pasteurized and raw samples at 24, 48, and 72 hours of age, whereas the fresh Pasteurized samples show more foam than the fresh raw samples. Pasteurized and raw cream testing 18 per cent butterfat gave similar immediate readings. One-minute readings were the same for both the fresh raw and Pasteurized creams. At 24, 48, and 72 hours of age the raw cream gave readings much greater than the Pasteurized cream. This is the reverse of the findings for skim milk.

With all the milk and cream studied, increased agitation resulted in increased amounts of foam. Results showed that foam production took place in vacuum at approximately the same degree as under atmospheric pressure.

In general, low temperatures (5° to 30° C.) do not cause a stable foam, whereas the higher temperatures (40° to 90°) produce a foam which is rather persistent.

DAIRY INTRODUCTION

J. H. McCLAIN, *in Charge*

DAIRY-HERD IMPROVEMENT

DAIRY-HERD-IMPROVEMENT-ASSOCIATION INVESTIGATIONS

On January 1, 1927, there were 837 dairy-herd-improvement associations containing 362,014 cows as compared with 777 associations and 327,653 cows on January 1, 1926. From January 1, 1927, to June 30, 1927, the number has increased to about 900 associations. Approximately 180,000 yearly individual cow records are now being received from 484 associations.

Over 100,000 yearly individual cow records were tabulated to show the relation of butterfat production to income over cost of feed. This work showed that the cows producing 400 pounds of butterfat a year brought in 10 times as much income over cost of feed as those producing 100 pounds of butterfat.

A very important feature of herd-improvement-association work is the proving of bulls used in these associations by comparing the records of five or more of their daughters with the records of the dams of the daughters. Two hundred and seventy bulls have been proved in this way. It was found that the dams averaged yearly 353 pounds of butterfat and the daughters 391 pounds. Thus the bulls raised the standard of production by 38 pounds, or 10.9 per cent. The study also showed that when purebred sires in dairy-herd-improvement associations were mated with cows producing as much as the average cow of the United States—approximately 180 pounds butterfat—the production records of the daughters excelled those of the dams by 67.6 per cent.

About 25 per cent of the 270 sires studied were mated with cows producing more than 400 pounds of butterfat. Approximately half of those increased the production of the daughters over that of the dams of the daughters.

A tabulation of 101,162 individual cow records showed that the purebreds excelled the grades in production of milk and butterfat and in income over cost of feed for each age until the cows reached the age of 11 or 12 years. On an average the purebreds excelled the grades by 754 pounds of milk, 19 pounds of butterfat, and by $8.66 in income over cost of feed per cow.

DAIRY-HERD-IMPROVEMENT-ASSOCIATION METHODS

This bureau, in cooperation with the cow-testing committee of the American Dairy Science Association, has given much assistance during the year in standardizing herd-improvement-association work throughout the country. The standard rules approved by the American Dairy Science Association have been adopted in their entirety in States having 40 per cent of the herd-improvement associations. With the exception of two rules, they are in effect in States having 90 per cent of these organizations.

Methods of organization and publicity in herd-improvement-association work have been studied. At the present time the States having 77 per cent of the associations have definite training courses at the colleges for testers.

PUREBRED SIRE INTRODUCTION

During the year six county scrub-bull-eradication campaigns and one state-wide campaign were conducted in cooperation with the extension services of several States. As a result of these campaigns 532 purebred dairy bulls were placed and 396 scrub bulls were eliminated.

Proved-sire work and cooperative bull associations have received attention, principally as an investigational study.

DAIRY MANUFACTURING

BUTTER AND CREAMERY WORK

A study is being made to determine the maximum percentage of acid that cream may contain when churned without producing a deleterious effect on the quality of the butter during storage. Preliminary results indicate that during eight months' storage at 0° F., butter made from cream containing 0.22 to 0.31 per cent acid deteriorates but little more than butter from cream containing only 0.15 per cent acid. Butter made from cream containing 0.35 per cent acid deteriorates considerably more, whereas the deterioration of butter made from cream containing 0.45 per cent acid is still greater.

In five States where improved methods of creamery operation are being demonstrated, monthly or bimonthly butter scorings were held at which time samples from the various creameries were scored according to the usual market standard and composition tests were made. These scorings are occasions for conferences of the creamery men, affording them opportunities for comparing the quality of their butter with that of neighboring plants and for discussing current problems with the dairy manufacturing specialist and with fellow creamery men.

FIELD WORK

The work in introducing the manufacture of American cheese in the mountain regions of North Carolina which has been conducted for several years in cooperation with the State extension service was taken over by the State during the year. The development of this work in Tennessee was continued.

The introduction of the culture method of making Swiss cheese in Ohio, New York, and Wisconsin was continued in cooperation with the universities of those States. Progress is being made in applying this method under field conditions. One large manufacturer reported that at his factories using the culture method, 85 per cent of the cheese was graded fancy and No. 1, whereas at his factories using the old method only 40 per cent was fancy and No. 1.

The manufacture of concentrated sour skim milk was demonstrated in several factories seeking additional outlets for surplus skim milk. A high-quality product is being made in all the plants, and all report a good demand for their product.

The manufacture by 12 creameries of 727,854 pounds of sweet-cream butter for the United States Navy was supervised by this bureau. After 8 to 10 months in storage, samples of butter from all the creameries were examined and found to have maintained their fine quality to a high degree.

Factories making renovated butter were inspected regularly as in the past. One factory ceased making this product early in the year, leaving only five plants now in operation.

MILK UTILIZATION

During the past year the two workers on the milk-utilization project have organized and personally directed 11 milk-for-health campaigns in 7 States. In 10 communities these campaigns were county-wide, and rural school children, as well as the children in the cities and towns, were reached by the campaign activities.

WESTERN OFFICE

Work under this office is confined to the 11 Western States and comprises bull-association investigational work, which is a project conducted in cooperation with the extension service of the University of Idaho; cheese work, which embodies teaching improved methods of manufacturing Cheddar cheese; investigations in connection with the quality of milk received at cheese factories, together with suggestions for its improvement; and monthly educational scorings of cheese. In cooperation with local boards of health this office also carries on work for improving the local milk supplies of cities and towns. Suggestions for the arrangement of milk plants and for their efficient operation comprise part of this work. An

outstanding feature of this project is the surprise milk-scoring contests, 40 of which have been held during this fiscal year. These contests have been very popular in the West and have accomplished much toward improving the milk supplies in cities inaugurating them.

THE BELTSVILLE STATION

T. E. WOODWARD, *Superintendent*

FEEDING INVESTIGATIONS

It is well known that liberal grain feeding causes greater milk production. Whether such feeding is a matter of economy has been an open question.

Data have been obtained on 23 cows for periods ranging from 90 to 150 days. These cows were fed by the double reversal method in 30 to 50 day periods. One group received only enough grain to meet requirements according to the Savage standard; another group was fed an additional 2 to 4 pounds of grain per cow per day. Assuming the grain to be worth $40 a ton, it was found that the extra milk resulting from the heavier grain feeding cost from 40 to 80 cents a gallon for the different groups. As this is somewhat in excess of the usual selling price it is concluded that heavy grain feeding, at least not above the average standard, will pay only in dairies obtaining a high price for the product.

The experiment comparing sweet clover with grass for pasture has been in progress for three years. One plot of 3¼ acres was seeded to sweet clover in the spring of 1924 and again in the spring of 1926. In the spring of 1924 a similar plot was seeded to a mixture of orchard grass, bluegrass, timothy, red top, and alsike and red clovers.

The sweet clover has furnished 1,529 cow-days of pasture at a cost of 16.1 cents per cow per day. The grass has furnished 1,395 cow-days of pasture at a cost of 14.7 cents per cow per day.

In 11 out of 12 comparisons, in changing from sweet clover to grass the production was greater from the grass; in 9 out of 12 instances in which cows were changed from grass to sweet clover the production was greater from the grass.

DAIRY MANAGEMENT

Several cows are being milked once a day for whole lactation periods in order to compare the results with those of twice-a-day milking. Two cows have been started on this work, but only one has been milked as long as 30 days. In the first 30 days when milked once a day she gave 1,025.1 pounds of milk; in a similar period after a previous calving she gave 1,170.7 pounds when milked twice a day.

In the summer of 1926, in cooperation with the Insecticide and Fungicide Board of the United States Department of Agriculture, three fly repellents having sulphur as the supposedly active ingredient were tried out on 32 cows by this bureau. It was found that feeding these repellents had no effect. Failure was also experienced in finding sulphur eliminated through the skin of the animal, and for this reason it appears that there are no scientific grounds for assuming that such repellents would be effective.

FILLING SILOS WITHOUT TRAMPING

In the fall of 1926 the four silos at Beltsville were filled with only an occasional leveling and without tramping. The same tonnage was required for filling as in previous years when the silage was tramped, and it has kept in good condition. Apparently the practice is a success. However, unless the silage is partially leveled occasionally, the cobs will roll down the side of the conical mass and too many of them will collect at one point. In emptying the silo it is advisable to take a layer off the entire top of the silo every feeding as otherwise a normal proportion of the heavier and lighter constituents will not be obtained.

INBREEDING EXPERIMENT

The inbreeding experiment with grade cattle started in 1913 has been continued in spite of serious setbacks due to disposal of a considerable number of the breeding females in 1918 and to the inroads of abortion disease. Counting all ages, 25 females are now being used in this work. Production records are being made and photographs taken to show the effects of inbreeding. When the original bull became impotent he was replaced by one of his sons and the experiment continued. Data up to the present show no decrease in vigor or bad results of any kind among the inbred animals.

PUBLICATIONS AND EXHIBITS

A. B. NYSTROM, *in Charge*

The 37 new or revised publications issued by the bureau during the year include 22 scientific papers, 1 department bulletin, 2 farmers' bulletins, 3 circulars, 1 leaflet, and 8 dairy short courses prepared for the Radio Service. Three mimeographed news letters, consisting of the dairy-herd-improvement-association letter, formerly called the cow-testing-association letter, and the milk-plant and milk-inspector letters, were issued monthly by the bureau for the purpose of giving the results of investigations along these lines to those chiefly concerned.

In addition, 16 manuscripts of popular articles were edited for publication in trade journals, and numerous press articles were prepared for circulation by the Office of Information.

Two major groups of exhibits were prepared, one for the Sesquicentennial International Exposition at Philadelphia, Pa., and the other for the National Dairy Exposition at Detroit, Mich. The one shown at Philadelphia was started the preceding year but was completed in July, 1926. This exhibit represented 50 years of progress in the dairy industry of the United States from 1876 to 1926. The exhibit consisted of 10 glass-front cases, each representing a five-year period. Miniature models of the machine or articles developed, or colored illustrations of the article or person connected with the development of the industry, were displayed. Appropriate legends gave the historic facts about each exhibit. This exhibit was on display from July 1 to December 1.

The usual cooperation was given to the Office of Exhibits in preparing an exhibit for the National Dairy Exposition, held at Detroit, Mich., October 6 to 13, 1926. This consisted of nine booths giving information on dairy-cattle improvement, market-milk investigations, and dairy by-products.

U. S. GOVERNMENT PRINTING OFFICE: 1927

JAN
EXPERIMENT STATION FILE

REPORT OF THE ENTOMOLOGIST

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., September 1, 1927.

SIR: I submit herewith a report of the work of the Bureau of Entomology for the fiscal year ended June 30, 1927.

Respectfully,

L. O. HOWARD,
Entomologist and Chief of Bureau.

Hon. W. M. JARDINE,
Secretary of Agriculture.

DECIDUOUS-FRUIT INSECT INVESTIGATIONS

Investigations of deciduous-fruit insects have been carried out under the direction of A. L. Quaintance, as formerly.

CODLING MOTH

Investigational work in connection with the codling moth has been directed principally to the problem of arsenical-spray residues on apples and pears. This work is being done in cooperation with the Bureaus of Plant Industry and Chemistry and Soils and with several of the States. The Bureau of Plant Industry is giving special attention to the removal of spray residue by processes of washing with acid, and the Bureau of Chemistry and Soils is cooperating in the study of various insecticides which may be utilized in place of lead arsenate in the control of this pest. These spray-residue studies are being carried out both in the laboratory and in the field. In the laboratory, feeding and other experiments under accurate control conditions are under way to determine, for many materials, the proper dosage for codling-moth larvae of different ages. In the field orchards are being sprayed with a considerable list of possible substitutes for lead arsenate to determine their effectiveness on the insect and safety to the foliage. Among such materials under experiment may be mentioned different forms of arsenates of zinc, aluminum, iron, barium, calcium, copper, titanium, manganese, and magnesium. In addition, various silicofluorides are under test as well as numerous other compounds. The results of the work, which was begun in the spring of 1927, can not be reported upon at this time, although the indications are that some of these arsenicals may be used in place of arsenate of lead, thus meeting the objection to lead in this compound.

Field work relating to the codling moth is under way at the laboratories at Yakima, Wash., Wichita, Kans., Vincennes, Ind., and Bentonville, Ark., in cooperation with the agricultural experiment stations of these States. In addition to the laboratory and field studies indicated, experiments are under way in the use of bait traps in orchards for the destruction of the codling moth, with results moderately favorable. Thus, at Yakima, Wash., in a block of trees baited and sprayed, only 10 per cent of the fruit was wormy, whereas in an unsprayed and unbaited block 20 to 25 per cent of the fruit was wormy. Tests of various sprays as ovicides and larvicides are being carried on. Certain oil emulsions under test killed 98 per cent of the eggs deposited, but had less effect on eggs deposited after spraying. Nicotine sulphate at proper strength is also under test and results are promising.

Attention is also being given to auxiliary methods of codling-moth control, as in better packing-house and orchard sanitation and in the use of bands around the limbs and trunk of the trees for the destruction of cod-

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ling-moth larvae. It has been found possible to treat these bands with certain chemicals which kill the larvae after they have spun up. Among the most effective of these are certain naphthalene derivatives, as alpha and beta naphthylamine. It is believed that by the proper use of these automatic band traps the codling-moth population in orchards can be very greatly reduced, thus modifying the necessity for spraying, which often involves objectionable residues on the fruit at the time of harvesting.

As a part of the investigation looking toward the avoidance of arsenical-spray residues, a study has been begun as to the behavior of the insect under varying climatic and other environmental conditions. In addition the likes and dislikes of the larvae and adults are being inquired into, in the hope that something of value in control may be found. In the laboratory at Washington, D. C., extensive investigations have been begun to find and perfect, if possible, other insecticides than arsenicals which may be used on fruit and vegetable crops.

BLUEBERRY MAGGOT

The general situation in regard to the blueberry maggot in Washington County, Me., has not changed materially since the last report. The washing machines devised by the Bureau of Chemistry will enable the canners to continue to operate their plants until satisfactory field control can be worked out. The biologic work on the insect has included studies of such questions as depth of pupation, the effect of burning-over blueberry land, the species of berries infested, and studies of parasites. Special attention is being given to experiments in the application of poisons, principally calcium arsenate, and also to studies of the quantity of arsenical residue left on the fruit at harvest time. Comparative studies of the apple and blueberry maggots have been undertaken and a difference in size of the insects in all stages has been noted. Much information is being obtained on the parasites of this insect. *Opius melleus* has been reared in large numbers in emergence cages. This species is undoubtedly an important factor in the natural control of the blueberry maggot. In the dusting experiments sufficient acreages have been treated to permit the drawing of tentative conclusions as to the value of this work. It is believed that the flies can be killed before oviposition by timely applications of calcium arsenate. Some injury to foliage will result from this treatment, but it is felt that this can be corrected. Owing to the general practice of washing the berries before canning, it is believed that the residue of the arsenical insecticide will hardly prove a factor.

PEACH INSECTS

ORIENTAL PEACH MOTH

Special attention has been given to the oriental peach moth at the laboratories at Riverton, N. J., and Fort Valley, Ga. In New Jersey a survey was made of all parasites known to attack any stage of the insect, and two species, *Macrocentrus ancylivora* and *Trichogramma minutum*, have been given special attention. At times during the season from 90 to 100 per cent of the larvae found in peach twigs were parasitized by the former species. An intensive study has been made of baits attractive to the oriental peach moth. Several products, particularly corn sirup, refiners' sirup, brown sugar, and other sweet products at dilutions of 5 or 10 per cent attract many moths. Several fermenting fruits are also attractive. Tests were made in three orchards with baits as a means of control, but the results were unsatisfactory. A study has been completed on the response of the adults to colored lights. The moth appears to prefer colors near the violet end of the spectrum. Ultraviolet light is also rather attractive. Beginning with the spring of 1927 a more serious attempt than heretofore has been made to test insecticides for the oriental peach moth. One specialist is devoting his entire time to this phase of the work, which includes studies of ovicides as well as larvicides. Attention is being directed toward the possibility of developing a repellent which may be used in orchards during the period of growth.

In Georgia the life-history studies of the peach moth were concluded during the fiscal year. It has been ascertained that there are from five to six generations with a partial seventh each year according to weather conditions. Further observations indicate that the peach moth is not likely to become a serious pest in southern districts.

PLUM CURCULIO

Extensive laboratory experiments have been made at the Fort Valley, Ga., laboratory to determine the tox-

icity of sodium and calcium fluosilicates, as well as a number of arsenicals, to the plum curculio on peach. One of the facts revealed as a result of these tests was that sodium fluosilicate against this insect is rendered materially less toxic by the addition of lime, whereas without lime it is very toxic to the insect, even more so than lead arsenate. Unfortunately, sodium fluosilicate without lime can not be used on peach trees by reason of the severe injury to fruit and foliage. It is possible that this situation may be corrected by further experiments. The arsenates of tricalcium, barium, and zinc, in the order named, were also found rather toxic to the insect. The arsenates of magnesium, manganese, and aluminum were less toxic.

In connection with further tests of materials against the peach-tree borer, applications of alpha naphthylamine were made to 1, 4, and 6 year old trees. Although no injury to the trees resulted, the chemical was found worthless against the insect.

Further studies of the so-called "cat face" of peaches have been made at the Vincennes, Ind., laboratory in cooperation with Purdue University Agricultural Experiment Station. The caging tests of 1926 were repeated in the spring of 1927, and again showed conclusively that some of the injury is caused by the tarnished plant bug. Four additional species of stink bugs, however, were found as contributing to the trouble. These all belong to the genus Euschistus, are very similar in general appearance and life histories, and probably can be controlled by one and the same method. These insects feed on a long list of other plants, such as weeds and cover crops, which may be present in or close to the orchard. In a general way, observations indicate that the injury is worse in orchards in which weeds were allowed to grow freely the previous season, or which are close to rough, uncultivated land.

ORCHARD INSECTICIDES

ARSENICALS

A chemical study of the burning of peach foliage and fruit by arsenical sprays and dusts has been under way. Evidence thus far indicates that lead arsenate and calcium arsenate must be decomposed upon the leaf with the freeing of water-soluble arsenic before injury will occur. There was a considerable accumulation of soluble arsenic upon the leaf surface before its presence could be shown within the leaf. As much as 0.001 milligram of arsenic pentoxide can be present within a leaf without injury being indicated. However, when the quantity is increased to 0.002 milligram, arsenate-pentoxide injury begins to appear. It was found that all materials which, when added to lead arsenate, reduced injury did so by reducing the quantity of soluble arsenic in solution. The problem resolves itself into the prevention of decomposition of a soluble lead arsenate into soluble arsenic. This is best accomplished by regulating the P_H of the spray solution to the composition. This promising field of investigation will be given further attention.

OILS

Further studies of oil emulsions, especially for the control of the San Jose scale, have been made. These included the influence of the quantity and kind of emulsifier used, and the influence of Bordeaux mixture on the effectiveness of the oil emulsion when the two are used in combination. In addition the possibility of the use of highly refined white oils in the summer on peach is being investigated. It has been found that the use of Bordeaux mixture with oil emulsion at low concentrations in peach spraying for the simultaneous control of peach-leaf curl and the San Jose scale tends to reduce the efficiency of the oil spray materially at concentrations up to 1.5 per cent of actual oil; at higher strengths under experimental conditions no difference has been evident. No injury to dormant trees has resulted from repeated annual treatments of oil emulsions up to 20 per cent of actual oil. In Georgia, for instance, peach trees have received the fifth consecutive annual treatment of 3 per cent oil emulsion without apparent damage. Definite experiments to determine the danger limit on peach trees by all concentrations show that a spray containing less than 25 per cent of actual oil caused no injury. The twigs, however, are killed at the tips by the 25 per cent strength, and sprays containing 40 to 65 per cent of oil have caused severe injury, killing branches almost back to the trunk. At the Fort Valley, Ga., laboratory attention has been given also to the standardization of the oil content of lubricating-oil emulsions, and this has proved very beneficial to the fruit grower.

Oil investigations in the laboratory in cooperation with the Bureau of Chemistry and Soils have been contin-

ued with special reference to the toxic effect of petroleum oils on aphids with relation to the size of the oil drops. The results of this work have recently been published in the Journal of Agricultural Research. Investigations have been started in connection with the arsenical-residue studies on the action of organic compounds as stomach poisons. While considerable time was necessary to organize this work properly, it is now well under way, and results of importance are anticipated.

DIPYRIDYLS AND ALLIED COMPOUNDS

During the past year a report on this subject has been published under the title, "Toxicity of Dipyridyls and Certain Other Organic Compounds as Contact Insecticides." In all, 35 compounds in this series have been prepared and tested as insecticides, and among these is one which has repeatedly shown high toxicity. This project, which is being carried out in cooperation with the Bureau of Chemistry and Soils, will be continued.

PYRROLES AND RELATED COMPOUNDS

The work done with these compounds, also in cooperation with the Bureau of Chemistry and Soils, has resulted in the development of a number of compounds which have been prepared and tested for insecticidal action. Effort has been made to synthesize compounds that are closely related to nicotine, and valuable information on the subject is being accumulated.

GRAPE INSECTS

GRAPE BERRY MOTH

The investigation of grape insects has been directed largely toward obtaining information on means of controlling the grape berry moth, and at the same time avoiding an undesirable quantity of spray residue on the fruit at harvest time. It is clear that the usual sprays against the second or later broods of this insect will be objectionable from the residue standpoint. The investigations, therefore, include studies of such points in cultural practices as may effect a reduction of the overwintering brood of the insect, thus contributing to its control. Various methods of applying sprays against the first brood are under investigation and will be continued. A study of conditions in localities where the grape berry moth is most destructive shows it to be imperative to greatly develop supplemental control measures and to place greater emphasis on more thorough work against the first brood, in order to reduce injury to the minimum. The following four principal lines of work have been commenced: (1) An investigation of the cultural practices thought to effect a reduction of the overwintering brood of the berry moth in vineyards. In cooperation with growers, large-scale cultural treatments are under way with this objective in view. (2) An effort to ascertain the degree of grape berry moth control which can be secured with arsenical mixtures applied against the first brood. (3) An effort to ascertain to what extent residues left from midseason applications of lead arsenate may be reduced by changes in the mixtures formerly used. This work includes field tests of mixtures applied earlier than has been the usual practice. It also includes tests of mixtures containing a decreased dosage of lead arsenate, and tests of spreaders, such as oils, thought to be less adhesive than the resin-fish-oil soap commonly employed. (4) Tests in vineyards to ascertain what arsenicals or other materials may be substituted for lead arsenate, especially in late applications, in view of the objection to the lead itself.

The widespread interest in vineyard dusting, caused by a demand for a method requiring less time than spraying and one which might permit late applications of arsenicals for the berry moth, has necessitated attention to this subject and it will be further emphasized another season.

THE ROSE CHAFER

Tests looking toward control of the rose chafer in vineyards have been continued in cooperation with the State department of agriculture and State extension service of Pennsylvania. A large number of materials have been under test, all in comparison with a mixture of lead arsenate and molasses or glucose, which has shown a high percentage of control. Doubling the arsenical dosage increased the death rate of the insects, but apparently gave no additional protection to the blossom clusters. It was ascertained that the proper time for applying sprays is exceedingly important, the most satisfactory control being obtained by spraying when the beetles first migrated into the vineyards and commenced feeding. Pyrethrum-soap emulsion was found to be highly toxic, killing a high percentage of the beetles within a 24-hour period after spraying.

The use of this material, however, affords no protection against the incoming migrants. Dusts of sodium fluosilicate and of barium fluosilicate and sprays of sodium fluosilicate in Bordeaux mixture, while slowly toxic to the beetles, afforded no protection against feeding. Burning of both blossom clusters and foliage resulted from the use of sodium fluosilicate. A number of attractants, including essential oils, alcohols, and fruit juices, were tested, but none proved effective in attracting the insects.

GRAPE LEAF HOPPERS

Further experiments with nicotine sulphate, applied just as the nymphs became injurious and at the time most of the eggs of the overwintering brood had been laid, confirm the results of previous tests as to the ovicidal action of nicotine and show that more complete protection of the vines can be obtained by spraying earlier than has been the usual practice. Experiments under way include tests of a number of oils, preparations of Derris, etc. A commercial Derris preparation has shown results on the nymphs of grape leaf hoppers which compare favorably with results obtained with 40 per cent nicotine sulphate, but the results to date indicate that the ovicidal action of this material is inferior to that of nicotine. Dust applications of nicotine against the nymphs of the grape leaf hoppers have shown fair control, but the percentage of kill is lower than that obtained from liquid applications made with vineyard spray booms.

PREVENTING SPREAD OF THE JAPANESE AND ASIATIC BEETLES

This work has continued under the direction of Loren B. Smith.

THE JAPANESE BEETLE

In the fiscal year the Japanese beetle was found to be established in the States of New York and Connecticut. Several colonies were discovered in Kings, Queens, and Nassau Counties on Long Island, and in Westchester County, N. Y., and in the city of Stamford, Conn. The insect spread westward as far as Easton, Allentown, Bethlehem, Lebanon, and Harrisburg, Pa., besides establishing numerous colonies in northern New Jersey. The spread to the southward was very small, and only one additional township in Delaware was found to be infested. A single beetle was discovered in the city of Washington, D. C. Two beetles were found in the Louden Park Cemetery, Baltimore, Md. A small colony of beetles was discovered at Gettysburg, Pa., although no additional beetles were found between that point and the area then under regulation in Pennsylvania.

Within the infested area the beetles became exceedingly numerous over a region of approximately 700 square miles. The city of Philadelphia was invaded several times during the summer of 1926 by large numbers which apparently flew from the heavily infested regions in New Jersey. The presence of large numbers of beetles in the freight yards greatly complicated the effective enforcement of the quarantine on farm products.

The damage to fruit trees and ornamental plants continued to be as severe as in previous years. A small area near Riverton, N. J., where the beetles have occurred in the United States for the longest time, apparently was not so heavily infested as in previous years. In Burlington County, N. J., which has suffered the most severe losses from the Japanese beetle, well-cared-for orchards are being protected from attack, although considerable additional expense is entailed to the fruit growers through the extra spraying of arsenicals which is necessary. In the suburban regions of Philadelphia shade trees, shrubs, ornamental plants, and garden crops are suffering increased damage as the beetles are becoming more numerous. The heavily infested area comprises less than one-tenth of the area under quarantine, and its increase is relatively slow compared with the annual increase of the infested territory as a whole.

Appropriations during the year were approximately the same as they were during 1926. The work of certification of nursery stock and farm products, the movement of which is regulated under State and Federal quarantines, has been greatly increased on account of the larger regulated area. The investigational phases of the work have been broadened to meet the new problems continually arising. Investigational projects are being completed as fast as possible, and reports on several phases have been prepared or are in course of preparation for publication.

INSECTICIDE STUDIES

As a result of several years' exhaustive study a coated lead arsenate has been developed which gives in-

creased protection to foliage and fruit, and kills a much larger proportion of the insects visiting the plants than the commercial acid lead arsenate. From 60 to 70 per cent of all Japanese beetles visiting trees or plants sprayed with this material during the summer of 1926 consumed a lethal dose. Since this coated lead arsenate has excellent adhesive qualities it can not be used on fruit or plants intended for food without danger to the consumer. It has also been found unsafe to apply acid lead arsenate in sufficient quantity to give adequate protection to certain varieties of peaches and apples which ripen early in the season. It has been necessary, therefore, to begin an extensive study to find substitutes for arsenicals which, used on fruit and vegetables, will protect the plants from the Japanese beetle without danger to the consumer. Over 200 chemicals are being investigated, and several have been found which offer a possible solution of this difficult and important problem. The benzol and naphthalene derivatives are being given special attention, as also the possibility of developing a cyanide which will be effective for a short period, and will then disintegrate and disappear before the products to which it is applied are to be harvested.

Because of certain difficulties encountered in the use of a pyrethrum soap developed as a contact insecticide by the Japanese-beetle project two years ago, a detailed study of various kinds of soap and their action on insects has been undertaken. This has led to considerable improvement in the preparation of a contact insecticide for the Japanese beetle. The commercial use of geraniol is being developed. This material is exceedingly attractive to the Japanese beetles and will concentrate them in large numbers in a relatively small area, where they can be killed by a contact insecticide. A trap baited with geraniol has been devised which will capture from 3 to 4 quarts of beetles in one day.

The carbon-disulphide emulsion developed last year has been found to have certain qualities which render it unsuitable for use in cold weather. It has therefore been necessary to continue the studies of emulsions of this material with the object of developing one which will not stratify in temperatures as low as 32° F. The carbon-disulphide emulsion developed at the Japanese-beetle laboratory is in general use in many parts of the country for the control of other insect pests.

Investigations of the use of lead arsenate to control Japanese-beetle larvæ in soil are being continued. It has been found that this material when placed in soil at the rate of 1,500 pounds to the acre is effective for a period of at least five years. It is now being successfully used to control Japanese-beetle larvæ and other soil-inhabiting insects on many of the golf courses near Philadelphia.

The effects of certain colors on the Japanese beetle are being investigated, since it is believed possible that advantage can be taken of the reaction of the insect to colors as a means of increasing the effect of certain insecticides that are being developed for its control. Furthermore, chemotropic studies are being made with reference to both attractive and repellent odors.

As the quarantine regulations governing the movement of nursery stock contemplate the treatment of soil to free it from any possible infestation of the insect before shipment, much work has been necessary in developing means of treatment for numerous varieties of plants. Over 1,000 varieties of nursery and ornamental plants are grown commercially in the area regulated on account of the Japanese beetle, approximately 50 per cent of which must undergo chemical treatment before certification for shipment to points outside the regulated area. Carbon disulphide has thus far been the principal means of exterminating infestations in or about the roots of nursery stock. During the year it has been possible to develop a hot-water treatment for certain types of nursery stock with soil about the roots. The adoption of this treatment has been estimated by one nurseryman to effect an annual saving of $17,000 to his nursery alone. Chemical studies are being conducted of solid naphthalene derivatives as soil insecticides and of the comparative toxicity of various organic sulphur compounds, particularly the xanthates and mustard oils. Volatile organic compounds, toluidine compounds, and inorganic cyanides are also being studied.

PARASITE INTRODUCTION

Progress in the introduction and liberation of foreign parasites of the Japanese beetle has continued during the year. Shipments of parasite material are being received continually from Japan, China, and India. Seventeen species of parasites of this insect have thus far been discovered. Very successful results are being ob-

tained in the introduction of several species of solitary wasps belonging to the genus Tiphia as a result of the discovery of a method of shipping the live adult wasps from Japan, Chosen (Korea), and China to the United States. The bureau is thus enabled to make large shipments of these parasites with relatively small mortality en route. During the autumn of 1926 it was definitely proved that *Tiphia popilliavora*, an important parasite of the Japanese beetle in Japan, has become established in New Jersey as a result of three years' liberations. Although the established colony is still very restricted in area, the degree of parasitism on the Japanese-beetle larvae has reached approximately 15 per cent, and the colony appears to be in a vigorous condition. The introduced tachinid *Centeter cinerea* increased the area of its distribution in New Jersey and Pennsylvania from approximately 48 square miles to 60 square miles during 1926. At the close of the fiscal year there is evidence of further spread of the established colonies of this parasite. As this is the primary parasite of the Japanese beetle in its native home, it is felt that its establishment in this country will aid greatly in the eventual control of the beetle. Large shipments of *Ochromeigenia ormioides*, *Prosena siberita*, and *Dexia ventralis* were received in New Jersey in 1926. During the year it has been necessary to curtail the parasite work in China because of unsettled conditions in that country. Other species of parasites have been found in India which offer possibilities, provided that they can be successfully shipped to this country. A shipment of over 25,000 cocoons of an unnamed Tiphia was made from India during 1926.

ECOLOGICAL STUDIES

The studies of the reaction of the Japanese beetle to its environment are being continued. These should be of help in determining how important a pest the Japanese beetle may become in other sections of the United States. General ecological studies are being continued to determine the reaction of the beetle to temperature, moisture, and other natural conditions. Further observations are also being made on the life history and biology of the beetle.

QUARANTINE AND INSPECTION

The Bureau of Entomology, cooperating with the Federal Horticultural Board and with the States of New Jersey, Pennsylvania, Delaware, New York, and Connecticut, has continued its efforts in the enforcement of Federal and State quarantines to prevent the spread of the Japanese beetle. Every effort has been made to enforce the quarantine in the most effective manner. A revision of the quarantine in the fall of 1926 brought under regulation an area of 13,919 square miles, including the city of New York, portions of Westchester, Kings, Queens, and Nassau Counties, N. Y., and two townships in Connecticut, including the city of Stamford. This area contains more than 11,000,000 people. During the summer of 1926 the inspection of farm products was required between June 15 and October 15, and this included inspection of sweet corn, peas and beans in the pod, cabbage, parsley, carrots, beets and onions with tops, lettuce, outdoor-grown flowers, hay, straw, unthreshed grains, and forage crops. The quarantine regulations also required the inspection of nursery, ornamental, and greenhouse products, sand, soil, earth, peat, compost, and manure.

The general procedure in quarantine enforcement was much the same as for the last several years. Inspectors were stationed at points convenient to the areas where restricted articles were grown and were subject to call by the growers when the inspection of any restricted articles was required. To prevent the movement of contraband articles, patrols were established on most of the roads leading out of the regulated area, their duty being to make sure that no trucks or other vehicles passing out of the regulated area carried uncertified products. In Philadelphia a special platform was established at a point convenient to the railroad yards and to this platform all produce that was being shipped from the markets was hauled for inspection and certification. At certain times during the summer of 1926 the presence of large numbers of beetles in the business district made it necessary to discontinue temporarily the inspection and certification of farm products from Philadelphia.

As a basis for the certification of nursery stock having soil about the roots, several methods of soil treatment have been devised whereby it is possible to destroy any infestation of the Japanese beetle which may exist in such soil. A separate organization has been developed, charged with responsibility for making all soil treatments, so that soil and plants with soil about the roots can be certified under

the Japanese-beetle quarantine. This organization has consisted of men thoroughly trained in the specific methods of soil treatment assigned them. The most rigid restrictions are enforced with respect to the application of these treatments so that no possible infestation can escape the treatment. In all, 29,804 trees and plants were treated during the season of 1926 for shipment to points outside the Japanese-beetle area. Of these, 1,710 plants were refused certification after treatment because conditions arose which caused some doubt as to the efficacy of the treatment in these cases. A continual check upon the efficiency of the treating solutions and methods is maintained by means of a check-up system. In addition to the field treatments, 4,359 roots and perennial plants of such a nature that they could not be inspected were chemically treated and certified for shipment to points outside the area.

During the year approximately 7,000 carloads and 46 barge loads of sand were shipped under certification from the Philadelphia territory. It is necessary when such sand or soil is shipped from an infested district to fumigate it before it is certified. In New Jersey 21,110 cars and 818 boatloads of sand and soil, consigned to 27 States and Canada, were shipped from the regulated area.

The total number of packages of farm produce certified from the regulated area during the year was 1,277,149, the total number of nursery plants certified was 33,518,380, and the total number of beetles removed from farm products was 141,998.

During the year a number of violations of both Federal and State quarantines occurred. Prosecutions were completed in 13 cases of violations of the Federal quarantine regulations, 8 of these arising from the interstate shipment of uncertified shipments of nursery stock and 5 from the contraband movement of farm products. Convictions were obtained and fines imposed amounting to $1,100. Two cases of violations were prosecuted under the Pennsylvania State quarantine and fines of $120 were collected. Two cases were prosecuted under the New Jersey State quarantine and $100 in fines was assessed.

SCOUTING WORK

Scouting to determine the spread of the Japanese beetle is systematically conducted each year by crews of men stationed outside the known infested area. The scouting crews are assigned definite territories and these are covered at regular intervals during the summer when the adult beetles are in flight. When they find infestations they are moved farther out from the known-infested territory. In this way it is possible to obtain fairly accurate knowledge with respect to the dispersal of the Japanese beetle each year.

It has been possible during the year to maintain an effective organization both from the standpoint of the shipper and from that of the enforcement of stringent quarantine regulations. With the addition of new territory and with the inclusion of New York City, greater difficulties are arising in connection with effective enforcement. The increasing abundance of the beetles in Philadelphia during successive summers is undoubtedly increasing the possible avenues by which the insect may be carried to points outside the regulated area. Although the unavoidable natural spread of the Japanese beetle by flight seems great, judging from the number of square miles included in the regulated area, it is believed that the regulations in force have prevented long-distance spread through the agencies of commerce, for the beetle, so far as known, has not become established at points far distant from the present infested territory. Nevertheless, to insure this in the future, the most stringent regulations must continue relative to the movement of nursery stock and soil.

THE ASIATIC BEETLE

The Asiatic beetle, *Anomala orientalis*, was discovered several years ago in New Haven, Conn. Since its discovery it has increased and spread, and in the spring of 1926 it was causing severe damage to lawns in approximately 27 city blocks in Westville, a suburb of New Haven. The larvæ feed on the roots of grasses and other plants and cause the complete destruction of the sod on lawns as well as injury to perennial plants such as iris, peony, and phlox. This insect is related to the Japanese beetle and its life history is somewhat similar.

Owing to the increasing damage caused by the Asiatic beetle, an emergency appropriation of $5,000 was made available during the year by Congress so that the problem of controlling this insect might be investigated. During the summer of 1926 scouting revealed that the insect was distributed generally in the southern

third of Long Island and in Westchester County, N. Y. Severe damage was caused to several large estates on Long Island where the insect was particularly abundant. Cooperating with the State of Connecticut, the department has carried on control measures for the purpose of reducing the infestation in New Haven. The treatment employed consisted in the application of emulsified carbon disulphide to the soil as is done for the control of the Japanese-beetle larvae in lawns. In all, 366 properties (43½ acres) were treated. Thirty-eight thousand pounds of concentrated carbon-disulphide emulsion and over 800,000 gallons of water were used. The soil treatment has been very effective in reducing the number of grubs throughout the New Haven area. A small laboratory was established at Westbury, Long Island, in the spring of 1927 and an investigator stationed at that point to make detailed studies of the insect and means for its control. Several parasites imported from the Orient which are effective on the Japanese beetle are also effective on the Asiatic beetle, and releasements have been made in the heavily infested areas on Long Island.

The Asiatic beetle is primarily a pest in the larval state to lawns and perennial plants. The adult beetles in the latitude of New York and Connecticut apparently feed only to a limited extent, the only damage by them that has been reported being injury to the blossoms of roses and hollyhocks.

THE JAPANESE GARDEN BEETLE

Late in July, 1926, a heavy infestation of beetles new to this country was discovered at Mount Vernon, N. Y. These were identified as *Aserica castanea*, an insect hitherto known to occur only on the islands of Japan. It belongs to a most injurious group, and further scouting revealed the fact that it had been established in northern New Jersey, eastern New York, and Long Island for several years but had been wrongly identified as a native species. This insect is commonly known as the Japanese garden beetle. The adults—small brown insects about one-half inch long—spend the greater part of the day in the soil, but emerge at night, at which time they are exceedingly active and very destructive. The adult has been observed feeding on approximately 50 different species of plants and probably feeds on many others. These include many garden plants and fruit trees. There is evidence that its numbers have been increasing from year to year.

WORK ON THE GIPSY MOTH AND THE BROWN-TAIL MOTH

This work has continued under the direction of A. F. Burgess, and has been carried on in close cooperation with the New England States, New York, and New Jersey.

RESULTS IN NEW JERSEY

At the beginning of the year careful consideration was given to the results obtained on the gipsy-moth scouting and general clean-up work in the barrier zone and in New Jersey. On account of the progress that had been made in reducing the infested territory in New Jersey, a plan of work was adopted which provided for intensive scouting work in the towns in the central part of the area where infestation was general at the time the work began. This has to be done with great thoroughness, as it is necessary to reinspect such areas for several years after the infestations have been treated in order to be assured that they are clean. The funds applied on this project were reduced about $30,000 from the amount spent during the previous year; therefore this central region was divided into two areas, one of which was to be given a very intensive inspection involving the examination of all trees in the area, including woodlands, while the other area, of approximately the same size, was to be given only general scouting. This arrangement contemplated that during the next year the plan would be reversed.

Owing to extremely unfavorable weather conditions in the winter of 1926 it was impossible to do any work in the town of Mendham, where a severe infestation occurred a number of years before, and this town, together with the heavily wooded areas on the Watchung Range in the northerly part of the townships of Bridgewater and Warren, and the large township of South Brunswick, were given special attention. As a result of this intensive work four gipsy-moth colonies were located in the town of Mendham, three in Bridgewater, three in Warren, and one in Bernard Township near the Bridgewater line. No infestations were found in the southern part of the territory, which includes the entire township of South

Brunswick, a portion of East Brunswick, and Montgomery. A single infestation was found in the township of Hillsboro in the area where general scouting work was done. Owing to unfavorable weather conditions small portions of North Plainfield, North Brunswick, and Montgomery, and most of Franklin Township were not examined.

No large colonies were found, and it is believed that as a result of the intensive clean-up and spraying operations conducted during the spring of 1927 the insect has been eliminated from these localities. More scouting will be required during the coming year to establish this fact.

The scouting work during the past year in New Jersey has been the most intensive and difficult that has been attempted in that region, as it has involved many large woodland areas in sections of rugged country as well as enormous swamp areas that are impassable except when frozen over. Inasmuch as all of the areas remaining to be cleaned up in New Jersey were once generally infested, it is not surprising that occasional colonies are found when very intensive work is done. The progress that has been made this year has been satisfactory, and by the close of next year, after the other half of the area has been intensively worked, it will be possible to determine how the work should be managed in order to complete the project in that State.

RESULTS IN THE BARRIER-ZONE AREA IN NEW ENGLAND AND NEW YORK

At the close of last year the plan of work in New England was revised, and it was decided to carry on intensive scouting in the towns where infestations had previously been found, and to curtail work in many of the towns that had been scouted for two consecutive years without locating the insect. A similar plan was followed in New York State in cooperation with the New York Conservation Commission. Federal work in the portion of the barrier zone lying in that State was confined to a strip of towns west of Lake Champlain extending from the Canadian border to Ticonderoga, but the entire area in Putnam was also scouted. The work was carried on very intensively in Essex, Willsboro, Chesterfield, and Moriah, as colonies of the gipsy moth had been found in the two last-mentioned towns in previous years. In the entire territory covered by the bureau in New York State no infestations were found this year.

As a part of the plan for the work in the barrier zone in New York State, the Department of Conservation undertook the scouting of Washington County and a group of towns encircling Kingston, where an infestation was found the previous year. That office also thoroughly scouted the colonies previously found on Long Island, and began a woodland scouting campaign on the east end of the island. In addition, intensive work was done by the State in selected areas in the barrier zone in Dutchess, Columbia, and Rensselaer Counties, where colonies had previously been found. In the area surrounding Kingston two small colonies were found, one in the township of Olive and one in Rosendale. They have been carefully treated, and a belt of territory 15 miles wide has been scouted beyond these infestations. Three colonies were found on Long Island, one each at Brooklyn and Patchogue, near areas that had been previously infested, and a small colony near Montauk. These colonies have been carefully treated.

In the last annual report attention was called to the increase in the acreage of defoliation in eastern Massachusetts and New Hampshire as compared with the infestation for a few years preceding, indicating that smaller infested spots were present in widely separated areas in Massachusetts, eastern Vermont, and New Hampshire. Attention was also called to the fact that if these infestations continued to increase great difficulty would be encountered in keeping the barrier zone free from the pest.

By adopting the plan already mentioned in handling the New England portion of the zone and by taking advantage of the reduced expenditures in New Jersey, it was possible to conduct general scouting work in a number of towns east of the barrier zone in Vermont and Connecticut.

During the year 32 towns in Vermont lying directly east of the zone were examined, as well as two towns in Connecticut. Thirteen of these towns in the northern part of Vermont and the two towns mentioned in Connecticut were found not infested, and they were removed from the gipsy-moth quarantined area July 1, 1927. In the remaining sector, which extends from Chittenden, Vt., southward to the Massachusetts line, three heavily infested areas were found, one each in Pittsford, Rutland, and Ira. The discovery of these colonies emphasizes

the value of this type of work, for if they had not been found during the year the infestation would have spread to some of the towns directly west that lie in the barrier zone.

In assembling available records covering conditions in towns between the Connecticut River and the barrier zone in Massachusetts it was found that the infestation, based on the number of egg clusters found, had increased 215 per cent over the year preceding and that some very large colonies had been discovered. While similar data are not available covering many of the towns east of the zone in Vermont and between the zone and the Connecticut River in Connecticut, it is known that the infestation, based on the number of egg clusters found, has materially increased.

All infestations found west of the river in Connecticut were treated by the assistants of the State entomologist, the Bureau of Entomology cooperating. Inasmuch as most of the towns west of the river in Massachusetts and Vermont had no facilities for spraying, an arrangement was made whereby two of the bureau's spraying outfits were detailed to treat the worst colonies in order to reduce the infestation and prevent spread. This work was done in 4 towns in Vermont and 13 towns in Massachusetts. All work done east of the barrier zone was made possible as a result of the savings in operation made on the New Jersey project and by the change in operating plan in the barrier zone.

At the close of the year only 1 town in the zone in Vermont was known to be infested, 8 in Massachusetts, and 7 in Connecticut. All have been thoroughly treated. A colony which was located during the year at Greenwich, Conn., which is in territory west of the zone, has been thoroughly examined, including an area for a distance of 5 miles, and no infestation has been found.

The small 1-ton truck sprayers which were perfected two years ago have been used effectively during the past season. They are particularly valuable for spraying small areas where light mobile equipment is necessary.

During the year several tests have been made for the purpose of improving and speeding up the spraying operations. Five small auxiliary pumpers were purchased which weigh about 200 pounds. By installing one of these pumpers at the water supply, which in many cases is located so that it can not be reached by trucks for drafting water, it is possible to fill the spray tank at a distance of 700 feet if the water does not have to be raised to too high an elevation.

Another experiment has been tried by constructing a partition in the spray tank so as to divide it equally. This makes it possible to fill one side of the tank with water by using the auxiliary pumper while the solution on the other side of the partition is being sprayed. By reversing the operation continuous spraying results. The adoption of this method will increase the efficiency of the spraying outfits about 35 per cent.

QUARANTINE AND INSPECTION

The number of certificates and permits issued during the year has increased but slightly over the number issued in 1926, the total being 151,353 as contrasted with 147,694 in 1926. Practically all of this increase was in nursery-stock shipments. The number of shipments found infested was not so large as the year before, but there was about 20 per cent increase in the number of clusters found and treated. Great care has been exercised in inspecting and certifying shipments, particularly those which originate in sections known to be infested.

As in the year before, the fall and winter shipments of Christmas trees and greens were very heavy. The shipping season for these products is an extremely busy one and the volume of inspection is so great that a large number of men from the scouting force have to be detailed for this work. The total shipments were 1,011 car lots, 1,019 small lots, and 114 auto-truck shipments. There was a small decrease in the number of car-lot and auto shipments because of removal from quarantine of some of the area from which Christmas trees and greens are shipped. The trees and greens were shipped to 38 States and the District of Columbia. One small tree was consigned to Manchester, England.

FIELD AND LABORATORY RESEARCH

Foreign work has been conducted along the same lines as during the previous year, with two entomologists stationed in Budapest, where they have been studying gipsy-moth conditions in Hungary and surrounding countries, collecting parasites and shipping them to America, and making a careful

study to obtain much-needed information on the alternate hosts of some of the multibrooded gipsy-moth parasites. This information is necessary so that the different species can be intelligently handled on their arrival in this country. A third entomologist has traveled during the spring principally in Italy and the Mediterranean countries and has collected and shipped valuable material from Algeria. More than 110,000 tachinid puparia have been received from Hungary and Jugoslavia, and additional shipments have come through from Poland. Over 21,000 cocoons of a species of Apanteles near *vitripennis* have arrived and a limited number of another species of Apanteles as well as an undetermined tachinid which attacks the satin moth in Hungary.

Colonization of parasites from the Melrose Highlands laboratory totaled 7,500,000 for the year. The new species that arrived from Europe have been colonized principally in a heavily infested area in southeastern Massachusetts, while the remainder were placed in more remote infestations, principally in towns where no parasites have been colonized heretofore.

Parasitism in general has shown a slight increase over the records for the previous year, but it is far below what is necessary to check the increase of the gipsy moth. Improved methods have been devised for collecting Calosoma beetles in the field in order to secure information as to their abundance and to obtain specimens for colonization.

Experiments with liquid sprays and with dusts applied by airplane have resulted in the accumulation of valuable data, but further work along these lines is required. Treatment of experimental areas with lead-arsenate spray indicates that effective results can be secured if the spray is applied by the time the foliage is one-half grown. This information will serve to extend the spraying season somewhat.

A general survey of the territory indicates that the gipsy moth is more abundant and that the defoliation is more severe this year than for several years past, the defoliated acreage being approximately double what was reported last year. Large defoliated areas were not confined principally to the territory on Cape Cod this year, as thousands of acres were completely defoliated in Essex and Middlesex Counties, Mass., and large areas were in a similar condition in a number of towns near Lake Sebago, in Maine, Conway and Moultonboro, N. H., in towns north and east of Worcester, Mass., and in the southern part of Rhode Island. The last-mentioned infestations are the most severe that have ever occurred in the southern part of that State. Present conditions indicate that more severe defoliations will result next year.

BROWN-TAIL MOTH

The brown-tail moth maintains its usual abundance in southeastern New Hampshire and southwestern Maine, but in other parts of the infested area in New England, except in a few isolated localities, it has not been seriously abundant. This species has been controlled to a very large extent during the last few years by imported parasites, which have proved more effective over a period of years than has been the case with the gipsy moth.

CEREAL AND FORAGE INSECT INVESTIGATIONS

Investigations of cereal and forage insects have been carried out under the direction of W. H. Larrimer, as formerly.

EUROPEAN CORN BORER

The severe destruction of the corn crop in southern Ontario, Canada, during 1926, as mentioned in last year's report, was viewed by hundreds of American corn growers, business men, and bankers, as well as many scientific workers, directors of experiment stations, extension workers, and others, and caused the gravest concern. The circumstances were such as to render it obvious that if some decisive steps were not taken immediately to repress the pest the heart of the Corn Belt would suffer early invasion, resulting in most serious consequences. This situation was responsible for the voluntary organization of a committee of corn growers, agriculturists, and business men, who decided that in order to cope with the existing emergency the sum of $10,000,000 in the form of a Federal appropriation would be required. The matter was presented to the President with the indorsement of the Secretary of Agriculture and received his approval.

The plan adopted provided that the corn growers in the most heavily infested regions in New York, Pennsylvania, Ohio, Indiana, and Michigan were to be required to clean up all corn débris existing on their premises and that they were to be reimbursed to an

extent not to exceed $2 per acre, subject to the approval of the Federal inspector, for such part of this work as was additional to that normal and usual in ordinary farm operations. Although it was conceded by all of the scientists concerned that extermination was impossible, and the entomologists of the department stated frankly that they regarded the project as a large-scale experiment in repression or control, it was felt that, in view of the obvious menace to the agriculture of the Corn Belt presented by the corn-borer problem, the project was well worth a trial; it was therefore recommended.

Ten million dollars for this project actually became available February 23, 1927, but since it was necessary to obtain State regulatory legislation to enable the project to go forward, the initiation of the work was delayed until March 14, when the first equipment was purchased and operations were begun. Under the leadership of the director of scientific work and the head of the division of cereal and forage insects all available resources of the department in Washington were coordinated and directed toward accomplishing what was undoubtedly the greatest emergency control program ever conducted under civil authority. A competent and efficient field organization was rapidly assembled by the administrative officer in charge of control, with headquarters at Toledo, Ohio. It was estimated that some 2,500,000 acres of cornland would be included in the area to be cleaned up and that the farmers could be depended upon to handle all but 500,000 acres of this, but as this area extended over a distance of some 350 linear miles from New York to Indiana, and included 64 counties, the machinery units necessarily had to be more widely scattered than otherwise would have been required.

This field clean-up campaign, conducted in cooperation with the State agricultural colleges, State departments of agriculture, and more than 300,000 farmers, came to an end on July 2 and, although weather conditions had been most unfavorable, the results attained by the farmers' own efforts were little short of marvelous. Estimates, based on actual counts, made immediately following the conclusion of the clean-up operations by men trained in this work, indicate that at least 95 per cent of the borers throughout the treated area were destroyed by this means. While the final results of this great control experiment can not be ascertained until the end of the present growing season, it seems reasonable to assume that, since millions of corn borers were destroyed, the results can not fail to be of considerable benefit. During the year some 10 publications dealing with control phases of the corn-borer work have been issued, some of them in very large editions. The most essential of these were, through the cooperation of the Post Office Department, placed in the hands of each box holder on all rural routes in the clean-up area.

The corn-borer research work during the year has met with gratifying success. A general conference of State and Federal research workers was called by the director of scientific work on January 6, at which the corn-borer research program of the department was outlined in detail and the investigational phases bearing either directly or indirectly upon the problem of control were freely discussed. Although enlargement of some of the projects was arranged for, it was the general opinion of those in attendance that practically nothing had been omitted from the combined program of the department and the States. The work of introducing the parasitic enemies of the corn-borer from Europe has progressed rapidly. Nearly 500,000 of these beneficial insects had been liberated in the infested parts of Michigan, Indiana, Ohio, Pennsylvania, and New York up to June 15 of this year. Similar work in New England has resulted in placing about 1,300,000 parasites in the infested fields of that region. Six species have been recovered in the field, thus indicating their establishment in America. The publications of the year dealing with research phases of the corn-borer work have been important. They were eight in number, the most comprehensive of them being A Progress Report on the Investigations of the European Corn Borer, published as Department Bulletin 1476, consisting of 154 pages.

ALFALFA WEEVIL

The work undertaken at the alfalfa-weevil laboratory at Salt Lake City, Utah, in 1927, included field tests of airplane dusting; the study of the part played by weather conditions in determining attacks of the insect; the storage, observation, and release of imported parasites; the study of the parasites already naturalized; and the mapping of the newly infested territory. Information is being obtained which, it is hoped, will make it possi-

ble to forecast alfalfa-weevil attacks so that communities may be organized for spraying and dusting operations, using methods developed by the bureau, in ample time to reduce losses to the minimum. The importation of European parasites, chiefly the species *Anaphes pratensis*, *Anaphoidea luna*, and *Peridesmia phytonomi*, has been continued on a small scale with the cooperation of the corn-borer parasite laboratory. The spread of the alfalfa weevil has been mapped with the aid of State entomologists. No considerable extensions of the infested regions have been found except along the Wyoming-Nebraska State line. The boundary of the weevil-infested territory is now everywhere in mountainous country, where there are few fields. Recent progress in practical control methods has been embodied in Farmers' Bulletin 1528, issued during the year.

HESSIAN FLY

Very little injury by the fall generation of the Hessian fly occurred in 1926 because continuous early fall rains largely prevented early seeding of wheat. Much volunteer wheat developed, however, which in general became very heavily infested by the early fall brood and served as the main origin of a heavy spring infestation of wheat planted in 1927 in many localities throughout the main wheat belt. Spring injury was particularly severe in south-central Kansas and Oklahoma. The widespread abundance of live puparia in the 1927 stubble constitutes a distinct menace to the 1928 crop unless parasitism and weather conditions are unfavorable. A plan has been put into effect this year to coordinate the bureau's studies of this insect in order the better to systematize the work, to make it more comprehensive and efficient, and to define more clearly the objective sought.

SUGAR-CANE MOTH BORER

The work of determining an efficient and economical control of this important pest of sugar cane has been vigorously pushed during the season. The work of introducing the Cuban parasites has been resumed on a larger scale than previously. Preparations have been made to test thoroughly, during the present summer, the soaking of seed cane in cold water and the dusting of the cane with sodium fluosilicate for the destruction of the pest.

INVESTIGATIONS OF INSECTS AFFECTING STORED PRODUCTS

E. A. Back has continued in charge of investigations relating to stored-product insects.

BEAN WEEVILS

The infestation of California beans and cowpeas with bean weevils has been unexpectedly high during the year. About 70 per cent of the farmers' consignments of beans grown in San Joaquin, Stanislaus, and Merced Counties were found infested upon arrival at warehouses. The actual money lost to farmers probably exceeded $1,000,000. The heavy infestation followed a poor market, which resulted in the holding over of many beans on the farm. These became infested in storage through lack of proper treatment, and furnished weevils for the infestation of the 1926 crop as it matured.

Since the research work of the bureau has determined the needlessness of such waste, hearty cooperation with all California agricultural agencies in the bean-growing areas has been perfected through cooperation with the California State department of agriculture. As weevil losses are registered in reductions in the amounts of cash paid farmers for the beans, it has not been difficult to conduct educational campaigns. Talks, demonstrations, and the setting aside of "bean weevil control weeks," in which business organizations have assisted, have taken place. Large numbers of samples of beans have been withdrawn from various farms and warehouses during the year for examination. These examinations have furnished data of value as a background for control. It is now recognized that community effort must supersede individual effort.

Fortunately Lima beans are seldom infested with bean weevils. At the request of the California Lima Bean Growers' Association six warehouses containing over 200,000 sacks of Lima beans grown in Ventura County, Calif., were examined for weevils late in the year, and no infestation was detected.

GRAIN INSECTS

As a result of the threatened loss to this country of the large export business in flour passing out through our southwestern ports to Europe, fol-

lowing the discovery at destination of heavy infestations by grain pests, effective cooperation has been established on the part of the Bureau of Entomology, Federal Horticultural Board, Public Health Service, Emergency Fleet Corporation, and the export millers in an attempt to suppress these pests in so far as they affect flour offered for export. It would appear that this crisis has been met successfully through control measures inaugurated in flour mills, railway stock, docks, warehouses, and ships.

The work on the Angoumois grain moth as a pest of wheat is nearing completion, the investigation having been continued along the same lines as last year. Special attention has been given to the determination of the relationship between infestation in storage and the degree of field infestation and the stage of growth that will first support the moth.

Large-scale experiments have been continued in Georgia, as during last year, for the purpose of gathering information regarding the gain to be derived from fumigation as a means of conserving stored corn from pests. The owners of one plantation in Louisiana are now effecting a saving of 3,000 bushels of corn by applying the information gained by the bureau.

DRIED-FRUIT INSECTS

The continued support by the California Dried Fruit Association of the bureau's investigation of insects destroying dried fruits and vegetables has been evidenced during the year by a contribution of $3,000. The research work reported upon last year has been continued and a number of bulletins prepared. The lowering of insect tolerance in figs by the food, drug, and insecticide administration has forced packers to give careful consideration to the curtailment of insect infestation. The need for entomological assistance in this crisis has been met by the enlargement of the bureau's activities dealing with the control of dried-fruit pests on the farm and in the packing house. During the year a committee has been formed representative of the California Dried Fruit Association, the University of California, the California State Department of Agriculture, and the Federal Department of Agriculture, to coordinate the work on dried-fruit problems.

FUMIGANTS

Cooperative work with the Bureau of Chemistry and Soils in search of promising fumigants that do not have the fire hazard of carbon disulphide has been continued. During the year laboratory tests have been made with over 200 aliphatic compounds. As a result of these tests a considerable number of promising compounds have been discovered. Large-scale tests are now being conducted to determine the efficiency and commercial value of a number of these. Ethylene dichloride in combination with carbon tetrachloride has proved to be a comparatively cheap, efficient, nonhazardous, and noninflammable fumigant, well adapted for use in commercial fumigating vaults. A paper has been prepared covering the experiments with this fumigant. A similar paper has been prepared covering work with a mixture of ethyl monochloroacetate and carbon tetrachloride which also shows considerable promise as a fumigant. A third paper has been prepared dealing with the alkyl formates as fumigants. Several of these show considerable value.

A number of large-scale tests with calcium cyanide and chloropicrin have been conducted in flour mills, warehouses, dwellings, and ships. Local applications of fumigants, as compared with general fumigation of the entire establishment, have been tested. The development of calcium cyanide as a fumigant for wheat in large elevator bins has been one of the big advances of the year in grain-insect control work.

FURNITURE PESTS

There has been an unusual loss during the past year because of the activity of furniture pests. Informal cooperative work has been initiated with furniture manufacturers and the producers of flax tow to determine the relative susceptibilty to insect attack of various vegetable materials commonly used in upholstered furniture.

The destruction of woolen covers by insects, particularly clothes moths, has enhanced the value of the bureau's work with mothproofing solutions. Several new solutions have been developed and tested during the year. It would seem as a result of this work that certain of the better solutions have a real value when properly applied, even though they may be of no practical

value if used as they are being used by the public at large. No solution has yet been found that will permanently and absolutely protect fabrics from insect attack.

MISCELLANEOUS WORK

Incidental to other work, investigations are under way dealing with the control of stored-product insects by means of heat and of cold-storage temperatures; the relative value of cold storage and normal storage under intelligent supervision; various household pests; and the protective value against insects of odoriferous woods, such as the various species of western redwood, eucalyptus, and camphor. Investigation is also being made of the pests of candy establishments, tanneries, meat-packing plants, cereal factories, and all sorts of storage warehouses; the value of various wrappers in protecting against infestation of packaged food supplies; the value of packing under partial vacuum as a means of preventing infestation, etc. These many activities have as their object the conservation of agricultural products during storage.

TROPICAL AND SUBTROPICAL PLANT INSECT INVESTIGATIONS

Investigations of tropical and subtropical plant insects have been carried out under the direction of A. C. Baker.

CITRUS INSECTS

In connection with the project regarding oil sprays and foliage injury, sprays satisfactorily toxic to insects have been found to show varying injury to citrus foliage. The factors responsible are being isolated, and oils of known content built up. Improved formulas under test have greatly reduced injury. Studies of oil sprays in relation to fruit size indicate that the sprays do not cause a reduction in size, as supposed by some growers. Similar tests of the effect of oil sprays on fruit maturity indicate that early fruit should not be sprayed for a few weeks before marketing. With midseason and late varieties this is not a factor. The influence of arsenical sprays in advancing the date of fruit maturity has also been under investigation. Fruit maturity can be advanced by such sprays, but the quality is much altered. Studies of the citrus aphid show that the condition of "flush," or the period of new growth of citrus, and temperature are the most important factors in outbreaks of this insect. Early and prompt treatment of local infestations has proved successful.

The occurrence of the Mexican fruit worm in the Rio Grande Valley of Texas has made necessary, in cooperation with the Federal Horticultural Board and the State of Texas, a campaign of eradication in the valley. By coordinating all agencies available a preliminary organization, largely of volunteers, made a thorough clean-up of all host fruits in the valley other than citrus. The board established a quarantine restricting the movement of the fruit permitted. A force to carry out inspection and to lead in future clean-up measures is being organized. Research plans as a basis for clean-up measures are under way. Such measures already adopted have thus far shown good results, no worms having been found in the valley since the campaign was completed.

BULB INSECTS

Because of the emergency in the bulb industry a laboratory was established in Washington State to supplement the laboratory in California. Work is being done on the biology and control of bulb-insect pests. Control experiments have involved the consideration of harvested bulbs, field plantings, and influence on forcing. In harvested bulbs the hot-water treatment is being perfected. One hundred per cent mortality of bulb-fly larvæ has been obtained at 60 minutes exposure. Results in terms of forcing show that the best time for the treatment of paper white narcissus with hot water is early in the season. They show also that these bulbs can not tolerate a temperature as high as 115° F. On the other hand, 110° F. gave satisfactory results. In connection with studies of bulb fumigation an apparatus has been perfected for the vaporization of carbon disulphide and is now being put under test in actual fumigation. A satisfactory control for the tulip aphis on iris has been found by the use of calcium cyanide, 2 ounces to 100 cubic feet.

FERN INSECTS

The leaf-hopper problem of the leather-leaf fern industry has been investigated by the laboratory in Florida, and a series of experiments were made which indicate that the insect can be controlled by the use of Derris extract.

AVOCADO INSECTS

The desire for importation of Guatemala avocados from Hawaii necessitated the study of these fruits as possible hosts of the Mediterranean fruit fly. Results indicate that under artificial conditions even those of the toughest skins may be attacked. These results will be supplemented by field studies.

CAMPHOR INSECTS

The continued injury by the camphor scale in Louisiana has resulted in a number of research problems, such as the measurement of the factors that influence the toxicity of oil sprays in the field, and the measurement of the influences that condition growth and host responses in the camphor scale. Results show that climatic factors such as air movement are important. These necessary and definite measurements, it is hoped, will permit intelligent prediction regarding the spread of the pest. A study of the biology of the Australian lady beetle has been undertaken which, it is hoped, will throw light on the whole subject of the use of parasites and predators, especially as to the failures in some work of this character.

TERMITE-PROOF BUILDINGS

In cooperation with the division of forest insects of the bureau, the Canal Zone laboratory has conducted successful termite-proofing tests. Here, where termites are very numerous, experimental buildings have remained termite free.

TRUCK-CROP INSECT INVESTIGATIONS

Investigations of vegetable and truck-crop insects have been continued under the general direction of J. E. Graf.

The latter portion of the year was notable for the unusual abundance of truck-crop pests with resulting heavy losses.

MEXICAN BEAN BEETLE

The Mexican bean beetle during the past season extended its range to a considerable extent, and infestations are now known in the North in Michigan, New York, and Canada, and in the Southeast at Norfolk, Va., and Lumberton, N. C. The intensity of infestation in the original Birmingham, Ala., area was as great in the past season as it was in 1920, the time of its original outbreak in the eastern part of the United States, when losses to the bean crop were outstanding.

Studies on direct-control measures have been continued. Extracts of pyrethrum have shown considerable promise as a means of controlling the beetle, applicable especially to small garden areas. The cost of this material will probably, for the present at least, preclude its use on a commercial scale. Of the stomach poisons under investigation, magnesium arsenate and calcium arsenate are the most satisfactory remedies for use under average conditions. Sodium fluosilicate and other fluorides can be used to good advantage, especially against the mature beetles, but care must be taken to avoid injury to the plants.

Life-history studies have shown that while there are four generations of the insect each year in the southernmost part of the infested area, only two were produced in the more northern sections. Records on winter survival of the beetle show that there was considerable mortality in the vicinity of Columbus, Ohio, where only 1.5 per cent successfully passed the winter, whereas in Birmingham, Ala., 10 per cent of the beetles passed the winter successfully. Life-history studies of the beetle in the Southwest have confirmed earlier observations to the effect that there is only one generation annually of the insect in that region, and that it spends about 252 days of the year in hibernation. The overwintering beetles are occupied in the spring over a period of 56 days in egg laying, the eggs being in evidence from the third week in June until the middle of September. Hibernation studies in which many thousands of beetles were used show that the yellow pine-oak associations are the most favorable hibernation quarters. Beetles in hibernation cages above this zone perished. At the upper edge of the pine-oak zone the winter survival was 2.4 per cent. In the middle of the zone the survival ranged from 22 to 36 per cent. Below the zone, in the piñon or nut pine region, 2.8 per cent survived the winter, whereas in the short-grass area of the valleys all of the beetles perished.

Experiments to determine the distance of flights of the beetles resulted in recovery after 24 hours of one beetle 3 miles from the place where it was released. Another beetle after four days was found 5¼ miles from the point of liberation.

PEA APHIS

Experiments were continued on the seasonal life history and control of the pea aphis under eastern conditions. Records were obtained on the multiplication of the pest on winter hosts, dispersal, factors influencing dispersal, and seasonal abundance. The work on control measures has been confined principally to the development of a machine for collecting the pest, and the results obtained thus far have not been entirely satisfactory because of seasonal conditions and their relation to the growth of the plant. Where peas were short and hardy, the "aphidozer" could be used to good advantage, but in the case of peas which had made a very succulent growth, considerable damage accompanied the use of the machine. In California, experiments in control measures show that the pea aphis is best controlled by the use of a dust containing 3 per cent nicotine applied at the rate of 40 to 50 pounds per acre with a temperature above 70° F. Two applications are necessary before the aphids become numerous and a canvas trailer attached to the duster should be used.

SEED-CORN MAGGOT

Studies on the seed-corn maggot consisted primarily of observations on the conditions which favor the attack of the pest on newly planted potato seed pieces. It was found that maggot attack was more prevalent under conditions which were unfavorable to the rapid germination of the potatoes, and also where potatoes had been injured by applications of fertilizers directly to the rows. Organic fertilizer or decaying vegetation in the soil proved attractive to the flies for egg deposition, and in soils which contained large quantities of such materials maggot injury to potatoes was more pronounced.

The present recommendations for obviating seed-corn maggot injury to potatoes are to plant them in well-drained soil at a time which is most favorable to their rapid germination; to mix the fertilizer with the soil at least 10 days prior to the planting of the crop; and to plant potatoes at such a depth that they will not be subjected to excessive moisture or severe low temperatures.

Studies on the life history and biology of the insect show that high temperatures are a deciding factor in the activity of the fly. Although it has not been determined where or in what stage the insect spends the summer in North Carolina, the indications are that it passes this period in the adult stage in damp and shady locations. Experiments were inaugurated to determine the relation between decay and maggot injury, and preliminary results indicate that the maggot will develop on decay-free sprouting corn and beans. Although efforts to rear the larva on bacteria-free potato seed pieces were not successful, it has not yet been definitely demonstrated that the insect will not attack sound seed potatoes. It is known, however, that conditions unfavorable to the proper corking of the cut surface of the potato furnish a favorable environment for the maggots.

STRAWBERRY ROOT LOUSE

The strawberry root louse has apparently become a most serious problem in some sections of the Chadbourn area of North Carolina. A considerable destruction of strawberry plantings during the last season was attributed to the work of this insect, although subsequent observations have shown that two other possible agencies might have been involved in the damage. The physical condition of the soil, due to the excessive use of inorganic fertilizers, followed by a dry period, or root diseases, may be responsible for a part of the injury. Further observations will be necessary to determine the exact rôle which the aphis plays in this injury. Control measures have been undertaken, but up to the present time no effective method of suppression has been developed. Studies of the biology of the strawberry root louse are under way to ascertain whether there is a vulnerable period in its life when it can be attacked by direct means.

RASPBERRY INSECTS AND MOSAICS

Studies have been continued with special reference to the insect population of raspberry plantings, with the result that three species of aphids, three of leaf hoppers, and two of plant bugs are being tested as to their connection with the transmission of virus diseases. Biological studies dealing with little-known aphids of bramble fruits are proceeding with particular reference to the possibility of their connection with these diseases. The egg, stem-mother, and sexual forms of *Aphis rubiphila*, hitherto unknown, have been discovered. Two shipments of berry plants infested with *Bembecia*

marginata and *Agrilus ruficollis* have been forwarded to New Zealand, where an effort is being made to control the berry plants, which are overrunning several important agricultural areas, by introducing their insect enemies.

SUGAR-BEET LEAF HOPPER

Quantitative studies on desert areas provided a basis for the analysis of climatic conditions for the 10 years preceding, and these were used to determine the possibility of forecasting leaf-hopper abundance. These analyses brought out a striking relationship between the character of the summer and winter preceding a crop year and the yield of beets obtained. On the basis of these data an official forecast was published through the medium of a circular letter and was made known in a series of meetings. The acreage campaign by a sugar company was based almost entirely on this information, and for the first time in the history of the industry in this territory a serious curly-top year (1926) was followed by an increased acreage, the plantings for the spring of 1927 practically doubling those of the spring of 1926. The optimism generated by the forecast was responsible for the extension of the campaign into an area generally considered submarginal as far as curly top was concerned, and that area is the only portion of the territory which is in any way affected adversely this year. Complete data on the final success of the forecast can not be made until the harvest this fall. Hibernation studies were made for use in preparing the forecast. The net effect of these studies thus far is to render very doubtful the interpretation of the relationship, previously accepted, between certain winters and the beet yields of the following year. It was previously believed that low temperatures as such were responsible for the elimination of the insect. Hibernation studies tend to show that it is not a direct relationship, since careful temperature studies of the soil surface indicate that killing temperatures were not reached.

Surveys to ascertain the distribution of the insect have been continued in collaboration with certain States and the Dominion entomological branch. The insect was discovered in Montana, and service was rendered to a sugar company prospecting the Bitterroot Valley as a potential sugar-beet area. By reason of the data accumulated by the bureau's sugar-beet laboratory in connection with forecasting and hibernation, it was possible to make a favorable report on the project. In cooperation with the University of California an explorer was sent to the Argentine Republic in the fall of 1926, in order to obtain information on the possible occurrence of the insect there. The sugar-beet leaf hopper was not found. In cooperation with the same institution, Olive Swezy was engaged to make preliminary studies on a possible causal organism found in the leaf hopper. A substation was established at Richfield, Utah, for studying the occurrence and periods of the sugar-beet leaf hopper, both in the cultivated area and in the extensive breeding grounds in and near the Escalante Desert. A technic was devised whereby leaf hoppers could be fed on artificial culture solutions, and this has materially enlarged the scope of studies on the relationship between the insect and the disease.

TOBACCO INSECTS

TOBACCO THRIPS

Observations over several years led to the belief that Paris green was a remedy for the tobacco thrips, since these insects largely disappeared from plants on which this poison was used for flea beetles. Cage tests with thrips have now been made and show that it is unable to thrive on tobacco plants dusted regularly with Paris green.

TOBACCO WIREWORMS

Tests with poisoned bait and kainit as an insecticidal fertilizer have failed to give any conclusive results against wireworms. In the field the bran-sodium fluosilicate bait seemed to give some protection to the tobacco plants, but this was not borne out in cage experiments. The most consistently beneficial results followed the use of stocky, vigorous plants, which seemed to be able to develop in spite of wireworm attack.

TOBACCO HORNWORM

Further attempts to put the chemotropic work with the hornworm on a practical basis were made. Both amyl benzoate and amyl salicylate are excellent attractants, but the cages for trapping the moths are too bulky, and no quick-acting poison to be used in the sirup bait has been discovered, though several have been found which apparently inhibit egg laying until the death of the poisoned moth.

MISCELLANEOUS INSECTS

Further studies on the tomato fruit worm have shown that the eggs are deposited by the female moth on the fruit buds and terminal shoots of the tomato plant and that the small larvae, upon hatching, feed upon these parts for a short period and then migrate to the tomato fruit. These observations are important, since they give an indication as to when the remedy should be applied to obtain the most effective results. The destructive possibilities of this insect are indicated by egg counts made from the middle of May until the middle of July, when over this period an average of 14 eggs per plant was found.

Further experiments have been made in the use of tanglefoot screens, placed on the borders of woodlands adjacent to strawberry plantings, as an index to the emergence and movement of the strawberry weevil from hibernation into strawberry fields.

The strawberry red spider is a pest of importance in Louisiana and other sections of the South. Dusting the plants with sulphur, 3 parts, and lime, 1 part, is a most effective remedy.

The pepper weevil continues to be a serious menace to the pepper-growing areas of California. Calcium arsenate as a direct-control measure shows the most promise, but caution must be exercised in its use, since Chile peppers used for drying are likely to carry some of the arsenate to the consumer. Early applications of the poison, however, should obviate this danger. Cultural experiments indicate that the weevil may be prevented from emerging from peppers buried to a depth of 3 to 8 inches. Some measure of control results from early winter destruction of the plants by disking and plowing, and the benefits are in proportion to the care exercised in this work.

An outbreak in California of the vegetable weevil, which was discovered during the preceding season, has gained in intensity, and the insect now appears to have a firm foothold in the San Francisco Bay section. It does damage to a wide variety of crops but is especially destructive to spinach. The insect continues to be a serious pest in Mississippi, where a study of its biology and experiments in control measures are in progress. This work is being directed principally to the use of poisoned baits in order to avoid the danger of arsenical residue on food products.

In cooperation with the Florida State Plant Board studies are being continued on the celery leaf tyer. Caterpillars of this moth are apparently difficult to kill with arsenicals. Experiments have been conducted in cooperation with the Bureau of Chemistry and Soils to determine the average arsenical residue on celery resulting from the various treatments and to determine a practical method for its removal.

PHYSIOLOGICAL STUDIES

Studies of the effect of arsenicals upon the respiratory metabolism of insects have established the fact that in general arsenicals reduce the normal metabolism of insects profoundly, the extent of reduction varying with the arsenical and the concentration employed. The trivalent form of arsenic was found to be more toxic than the pentavalent form, as shown by the more intense inhibition of the respiratory metabolism of insects under experiment. An electro-Gutzeit apparatus was devised for the purpose of quantitatively determining the degree of solubility of arsenicals in the digestive system of an insect. This apparatus was found very valuable in determining accurately the quantity of arsenic necessary to kill individual insects and to determine the residual arsenic on sprayed vegetables and fruit.

COTTON-INSECT INVESTIGATIONS

Investigations of cotton insects have been carried out under the direction of B. R. Coad, as formerly.

COTTON-BOLL WEEVIL

The emergence of the cotton-boll weevil for the spring of 1927 was heavier than for any year since 1923, and weather conditions have been fairly favorable for weevil multiplication, so that damage has been fairly serious. Unfortunately, the last three years, with almost total absence of weevil damage in many districts, have given the majority of farmers a feeling of false security, and it will be necessary constantly to direct their attention to the desirability of poisoning for the insect in order to avoid serious losses due to a probable increase of the insect. The experimental areas immediately surrounding the Tallulah, La., laboratory were all overflowed by the Mississippi River about the 1st of May, and most of this land remained

under water until about July 20: there is thus but little land in cotton in the immediate section of the laboratory. Because of this shortage of cotton fields and the abnormal conditions prevailing in the neighborhood, the bureau's program of experiments for the growing season of 1927 has been materially changed and curtailed. It has, however, been possible to increase the laboratory and more technical lines of investigation to compensate for this decrease in field work. The studies of width of dust swath have been continued on a more intensive scale than before, and it is expected that another season's work will permit final conclusions which may be used as a basis for rather important modifications in the general technic of dusting. These studies have been expanded to include observations on the duration of adhesion of different types of poison under different conditions and the resultant insect control.

The work in further development of ground dusting machines is largely centered around the production of high-velocity types, utilizing either a single spreader nozzle or a single oscillating nozzle. Several such machines have been constructed and tested to determine conditions under which they can be operated and the swath widths which may be treated effectively and most efficiently under varying conditions. Commercial firms have produced tentative models of such machines in limited numbers and the experience derived from their operation is being used in checking the bureau's experimental results. After some further refinement a daylight dusting machine will be available which can be used with wind velocities of probably not over 10 miles per hour. The relation of daily weather conditions to convection or air currents is proving very important in this connection, and a series of observations on this point will be necessary before final recommendations can be made. Sufficient progress has now been made in the development of equipment for delivering dust so that this can be made to adhere to the plants when dry. A further step in this machinery development will be the perfecting of devices which can be added to various types of cultivators so that the operations of cultivation and dusting can be accomplished simultaneously.

The airplane-dusting development has continued, involving the adaptation of equipment to various types of planes and the improvement of dusting technique. This has involved the development of equipment for the application of combined dusts, such as the sulphur-calcium arsenate mixture, or the calcium arsenate-nicotine mixture, with the idea of controlling a number of insect pests of the cotton plant by one and the same application.

The biological studies of the weevil at Florence, S. C., have been carried practically to completion and a manuscript is now ready for publication describing the life history and activity of the weevils under conditions existing in the Southeastern States.

COTTON FLEA HOPPER

The most striking entomological feature of the cotton-growing season of 1926 was a widespread outbreak of the cotton flea hopper. This damage appeared over the greater portion of the Cotton Belt and was very serious during the early months, consequently it was necessary to organize an extensive investigation of this comparatively new problem. The plant disorder caused by the flea hopper in many districts absolutely prevented the setting of fruit on the cotton plants until the normal period of fruiting was very nearly past. Fortunately an extremely dry summer and late fall permitted these plants to recover and make a late crop after the hoppers had left the cotton fields. Nevertheless, in many sections there was still a heavy loss of crop which can be attributed only to the hopper. Thus in Madison Parish, La., the yield of cotton for 1926 was scarcely more than one-half of that for 1925, although the acreage in cotton during these seasons was practically the same. It has been found that this plant disorder is not due to the activity of a single insect, but to a group of insects. Four different species belonging to related genera are already positively incriminated and perhaps other closely related insects will be found concerned in the same damage. A careful biological study of these insects is under way, as well as experiments in methods of control. Fairly satisfactory results have in most instances been obtained in destroying leaf hoppers through the use of dusting sulphur. There have, however, been instances of complete failure, and the best results have been obtained when dusting has been done on bright, hot, sunshiny days.

ARIZONA WEEVIL

The Arizona-weevil problem has become increasingly serious. Scouting in cultivated cotton fields in the fall of 1926 showed infestations of some years' standing throughout many new areas in southeastern Arizona where they had not been found previously. Regulatory and quarantine measures to reduce the likelihood of movement of the insect are being enforced as far as possible, and a careful check is being maintained on the old infestations which have been under observation in cultivated cotton for two or more years. A steady increase in damage by this pest in cultivated cotton has been noted. The biological investigations started some time ago have progressed to a point where weevils which have been permitted to breed on cultivated cotton for three years are under observation, and complete records are being maintained for the purpose of determining the changes in their activities which may be brought about by this change in environment. At the same time all possible information is being collected to serve as a basis for control measures. It has been found possible to obtain a fairly satisfactory degree of control of weevils hibernating in cottonseed by the use of steam sterilizers in the gins, and such a measure is now required through the entire infested area. One especially important development of the biological work has been in connection with hibernation. This weevil normally hibernates in a hard cell on the Thurberia plant, but with continued breeding on cultivated cotton it is noted that a fairly large percentage of the weevils leave this cell and hibernate in any available trash, in the same manner as does the ordinary boll weevil. Survival tests conducted under such conditions show that approximately 48 per cent of these weevils hibernating out of the cell survive the winter, and that about 70 per cent of those hibernating in this cell successfully pass the winter. In this connection it will be remembered that the survival of the ordinary cotton boll weevil in the Cotton Belt is only about 2.5 per cent.

COTTON APHIS

The cotton-aphis studies have been rounded out with particular reference to the interrelationship between weevil control and aphis damage. It has been found that the increase of the aphis which sometimes occurs following the use of poison for weevil control is due partly to the destruction of parasites of the aphis and partly to the fact that the winged adult aphids seem to be strongly attracted to cotton fields which have been whitened with the dust. As a usual thing injurious infestations of aphids appear to be produced only by the application of calcium arsenate at a time not necessary for weevil control and, as far as possible, damage is being avoided by recommendations for modifying weevil applications.

PINK BOLLWORM

The pink bollworm has now become so thoroughly established along the Rio Grande in western Texas that it has reached a point in numerical abundance where biological investigations are possible. A new laboratory is being opened in western Texas for the purpose of starting an intensive study of this species in the United States. At first particular attention will be paid to those points which are of special importance in connection with regulatory, quarantine, and control measures, but at the same time a thoroughgoing fundamental study of the species is being started.

THE FLOOD IN RELATION TO INSECT DAMAGE

Following the overflows of 1927 special studies were started in Louisiana, Mississippi, and Arkansas to obtain more definite information on the relation between floods and insect damage. As is well known, certain species of insects, particularly cutworms, army worms, and grass worms, are extremely injurious following floods. It also appears that boll-weevil injury is usually severe for two or three years following an overflow. The studies organized are to determine the exact causes of these phenomena and the best methods of meeting the various insect problems created by the overflow.

INVESTIGATIONS OF INSECTS AFFECTING MAN AND DOMESTIC ANIMALS

This work has been carried on under the supervision of F. C. Bishopp, with headquarters at Dallas, Tex.

SCREW WORM

Earlier work of the bureau indicated the great protective value against screw worms of destroying the carcasses of wild and domestic animals

before the maggots have a chance to complete their growth. This practice is being rapidly adopted by ranchmen, and where carried out systematically over a considerable area has been the means of gradually reducing the screw-worm hazard. Recent severe losses from the insect have greatly stimulated interest also in the control of the screw worm by means of flytraps. The operation of these throughout considerable areas of range country has necessitated further investigations, which have been carried out in cooperation with County Agent W. R. Nisbet, of Menard County, Tex. Special effort has been made to study the many factors which influence flytrapping under range conditions. Some of these have to do with the number of traps per given area, the distribution of the traps over the ranches, the frequency of baiting and emptying traps, the kind and size of bait used, etc. As a result of last year's trapping tests in Menard County, Tex., approximately 968 gallons of flies were caught in an average of about 230 traps. Certain ranches within the trap area, upon which records were kept of the number of screw-worm cases, showed an average during the season of about 1 per cent of the stock infested, whereas on other ranches outside of the trap area, but under similar conditions, the average infestation was about 10 per cent.

CATTLE GRUBS

The control work begun last year has been continued in cooperation with the Virginia Agricultural Experiment Station. This work involved the treatment of the backs of all cattle, something over 2,300 head, in the valley known as Burkes Garden in Virginia. During the spring of 1927 the infestation of cattle which were kept in the Garden throughout the previous summer was found to be about half as heavy as that of cattle which were not grazed in the area under experimentation. This indicates that a great reduction of the grubs may be brought about by cooperative effort on the part of the stock owners, but shows the difficulty of getting complete control where the treatment is purely voluntary and not very closely supervised. Further tests have been made of powders applied to the backs of infested animals for the purpose of destroying the grubs without any preliminary treatment. These tests indicate that certain tobacco powders of high nicotine content, free nicotine dust (1 to 3 per cent nicotine), and powdered Derris root will give a high percentage of kill if applied and brushed in at intervals of about 20 days.

FLY CONTROL ABOUT DAIRIES

Extensive experiments have been carried on to determine the toxicity of various insecticides and other materials to various flies which affect cattle and contaminate dairy products. Special attention has been given to pyrethrum extracts, and comparative studies of the toxicities of extracts made from Dalmatian, Japanese, and home-grown pyrethrum flowers have been carried on. The operation of a general program for the control of flies about dairies has been continued in cooperation with the Bureau of Dairy Industry on the Beltsville farm, Md. Flies gave very little trouble on the farm during the season of 1926. Part of this immunity may have been due to climatic conditions, but undoubtedly much of it is the result of the control practices carried on.

SHEEP SCAB MITE AND GOAT LICE

The cooperative work with substation No. 14 of the Texas Agricultural Experiment Station on the sheep scab mite and goat lice was continued throughout the year. Further tests of the longevity of scab mites in pens were made, and the results further emphasize the conclusion that the reinfestation of sheep by scab mites from infested premises is not likely to take place more than a few days after the infested sheep have been removed.

POULTRY PARASITES

Further biological and control studies have been made with the fowl tick or blue bug. Tests of exposure to adverse climatic conditions, particularly cold, indicate that this pest is able to withstand very trying climatic conditions, and that it may yet greatly extend its range of destructiveness to the poultry industry.

CREEPING ERUPTION OF MAN

The work on the malady known as creeping eruption has been continued in cooperation with J. L. Kirby-Smith, of Jacksonville, Fla. A very notable advance has been made in the knowledge of the causation of this troublesome malady by the demonstration that the causative organism is the larval stage of a tropical hookworm of dogs and cats, known scientifically as *Ancylostoma braziliense*.

INVESTIGATIONS OF INSECTS AFFECTING FOREST AND SHADE TREES

This work has been continued under the direction of F. C. Craighead, as in former years.

WESTERN BARK BEETLES

Although cooperation with private timberland owners and Federal officials in the technical administration of control projects has, as usual, demanded the major part of attention in the Western States, detailed biological and ecological investigations of three species of western bark beetles have been given some attention. These studies differ from those made earlier on the problem in that first consideration is being given to the environmental factors that govern the behavior of the insects themselves, the characteristics of the trees selected for attack, and the reaction of the tree itself during and after attack, in an effort to determine what influence these factors have on brood development.

Studies of the western pine beetle have brought out results that should have a wide application in matters relating to logging practice and management of forests where bark-beetle losses are a factor. By especially constructed cages it has been possible to study the reaction to beetle attack of trees of varying growth and crown characteristics. Present results indicate, other conditions being equal, that fast-growing trees offer the most resistance and slow-growing trees the least. In this respect the western pine beetle differs from the Black Hills beetle and several other important species, which are known to show little if any preference for slow-growing trees. Considerable attention was given to the predators which feed on the western pine beetle in its various stages of development. The most important of these appears to be a clerid, *Thanasimus nigriventris*. This insect is an important factor in natural control, both during the flight period, when the adults prey upon the attacking bark beetles, and during the larval stage, when the clerid larvae feed upon the bark-beetle broods. In control experiments it was found that when clerids were excluded from a section of infested tree, the emergence of the western pine beetle was as much as three times as great as when the clerids were not excluded. Life-history studies of this insect have brought out the point that in control work it is very undesirable to treat the summer-brood trees of the western pine beetle, as these trees carry over a considerable percentage of the clerid broods until the following spring, when the adults emerge and concentrate upon the first seasonal attacks of the bark beetle.

In the Kaibab National Forest attention was given to somewhat similar investigations of the Black Hills beetle. From the results of this work it was possible to predict the phenomenal decline in the epidemic on this area, with the result that there was considerable saving in control expenditure. This decline in the epidemic appeared to be caused by the extremely dry summer, with prevailing southwest winds, which had the effect of lowering the moisture content of the trees and interfering with the developing broods of the beetle. The accumulation of predators and bark-boring larvae also played an important part in the reduction of infestation.

EFFECT OF WINDFALLS UPON BARK-BEETLE INFESTATIONS

A study of the infestations developing in and around a large windfall on the Inyo and Mono National Forests was continued during the year in cooperation with the Forest Service. The volume of timber blown down in February, 1923, was estimated at 12,500,000 feet on an area of about 32,000 acres. Nearly one-half of this loss occurred on an area of 2,640 acres where the percentage of the stand blown down ranged from 20 to more than 50. Bark beetles began breeding in this down material during the season of 1923. No damage occurred in standing trees in or around the windfalls until the fall of 1924. In August and September of that year, however, thousands of trees near the windfall areas were top-killed by *Ips oregoni*. This species promptly subsided in 1925 but during the fall of that year there was a pronounced increase in the killing of standing trees by the Jeffrey pine beetle. The 1926 infestation was found to be the heaviest in the history of the area, and there was no indication of decline from this epidemic condition. The total loss of standing timber in 1924 and 1925 was estimated at 6,000,000 board feet. About 48 per cent of this loss occurred around the areas of heaviest windfall damage. As a result of these studies it is now believed that prompt salvage of the wind-thrown trees is the only feasible meas-

ure for preventing heavy insect losses in standing timber in and around areas of heavy windfall damage.

PROBLEMS UNDER INVESTIGATION IN COOPERATION WITH FOREST EXPERIMENT STATIONS

As noted in an earlier report, a decided need has developed for assigning entomologists to the Forest Service experiment stations. Thus far, funds have been available for direct cooperation in this manner at only three of these stations, one in the New England States, one in the Lake States, and a third in the southern Appalachians.

In the New England States the investigation of the white-pine weevil, supported in part by private timberland owners, has progressed satisfactorily. Additional information on obscure points in the life history of this beetle has been obtained which will have a direct bearing on prevention of losses. These observations relate chiefly to hibernation, feeding habits, and the flight of the adults. It is now felt that direct control of the weevil under forest conditions is impractical, and reduction of the damage must be secured by proper silvicultural methods. The most advantageous and cheapest way to accomplish the desired results is to grow white pine in mixture, preferably with some species of trees which will be of value in the final crop, such as hemlocks or the better hardwoods. Indiscriminate planting of white pine without regard to suitability of the site must be discontinued.

In the southern Appalachians, investigations have been centered on a study of the southern pine beetle. Conditions were particularly favorable during the summer of 1926 and several local outbreaks on the Pisgah National Forest furnished abundant material for study. The more important developments threw further light on the causes responsible for the phenomenal rise and decline of epidemics of this beetle. It was found that there are five and sometimes six generations each season and that the ratio between progeny and parent attacking beetles indicated a possible increase of from 300 to 1,000 per cent. Experimental drought plots clearly demonstrated the susceptibility to attack of trees weakened by an insufficient supply of moisture. A sudden drop in temperature during the last winter to about zero Fahrenheit produced a high mortality in all of the local outbreaks in the vicinity of Asheville, N. C.

In the Lake States the most important problem under study has been the tip-moth infestation on the Nebraska National Forest. The introduction of parasites was continued through large collections made on Nantucket Island, Mass., in the vicinity of Charlotte, N. C., and at Bogalusa, La. Some 8 or 10 primary parasites have been introduced, but it has not yet been determined whether any of them have become established.

COOPERATION WITH THE NATIONAL PARK SERVICE

This important work has been continued during the last year under cooperative arrangements between the National Park Service and this bureau. The entomological activities were confined to the Yellowstone, Crater, and Grand Canyon National Parks. The extensive mountain pine beetle infestation in lodgepole pine on the Crater National Park was completely cleaned up this year, and it is hoped that no further work will be necessary now that the main source of beetles (flight from the Crater National Forest to the north) has subsided. The timber along the roadways through the center of the needle-tyer infestation in the Yellowstone National Park was protected again in the last season. The green belt of timber that was sprayed stands out in striking contrast to the desolation on the more remote portions of the area. Some bark-beetle control work was done in the Yellowstone National Park and a survey of the results of bark-beetle control work in the Grand Canyon National Park demonstrated that this infestation has completely subsided.

STATUS OF THE MORE IMPORTANT BARK-BEETLE CONTROL PROJECTS

Three years of active control operations directed toward the suppression of the western pine beetle in the yellow-pine forests of southern Oregon and northern California furnished an excellent opportunity to test the efficiency of present methods of bark-beetle control and to indicate in what ways improvements might be made. During the three-year campaign, 1922–1924, nearly 400,000 acres were covered by the control operations, and 31,500 infested trees containing over 35,000,000 board feet of lumber were felled

and the bark burned, all at a total cost of approximately $145,000. This work demonstrated the practicability of carrying on large-scale control operations through the cooperation of a number of interested owners. However, because of the shortness of the control season and the limited quantity of efficient labor in the region, there is a limit to the size of control operations in any locality during a control season, beyond which it is not practical to increase them. The most outstanding result of the work was that it proved to the timber owners that the protection of high-priced pine stock from beetle attack was a paying investment.

In Montana the Beaverhead-Bitterroot control project which was started in May, 1925, was continued during the spring of 1926, its purpose being to check the spread of a severe epidemic of the mountain pine beetle which has been sweeping south along the west side of the Continental Divide since 1910. In 1925 the front of this infestation rested upon the headwaters of the Bitterroot River, but during the past two seasons it has crossed the Continental Divide into the Beaverhead National Forest. This infestation was of such magnitude that plans for treating all of the infested trees were impossible, and a zone of defense was established across the head of the epidemic, in which some 6,500 trees were treated. Though this zone was reinfested during the past season, the work was successful in that it prevented the spread of the epidemic into areas beyond. The plan of this project contemplates treating each year the infested trees within the zone of defense until such a time as the heavy blocks of infestation to the rear, from which the reinfestation comes, have died down.

Two smaller projects in white pine were continued in cooperation with the Forest Service in 1927, one on the Pete Creek drainage of the Kootenai National Forest and another on the Independence Creek of the Coeur d'Alene National Forest. Unfortunately a severe fire swept through the latter drainage in the summer of 1926, necessitating the abandonment of further check on this project.

A severe infestation of the Black Hills beetle was reported on the Colorado National Forest. Preliminary examinations indicate 500 per cent increase of infestation over the previous year. An entomologist was stationed there for the summer to assist in the technical features of control and to continue the general biological observations which were started on the Kaibab National Forest two years ago.

INSECTS AFFECTING FOREST PRODUCTS

Tests of wood preservatives for preventing insect attack to crude and finished forest products, as well as poisons for wood pulp and fiber products, have been continued both at Falls Church, Va., and on Barro Colorado Island, Canal Zone, Panama. Various types of mortars for brick or masonry foundation walls have been under test at Falls Church, Va., since August, 1926, to determine their relative effectiveness in preventing termites from penetrating through foundations. One type of mortar in common use failed within nine months. Increased interest has been shown by cities in several sections of the country in the adoption of suggestions for modifying city building codes to prevent damage to the woodwork of buildings. Cooperation in this work has been maintained with the National Commission of Wood Utilization, the Department of Commerce, the Forest Service, the National Lumber Manufacturers' Association, the American Wood Preservers' Association, and the Pacific Coast Building Officials' Conference.

An introduced South American termite, *Cryptotermes brevis*, already an injurious pest in southern Florida, has been discovered at New Orleans, La., and every effort has been made to stamp out this serious pest. A very destructive oriental termite, *Cryptotermes formosanus*, recently introduced into Hawaii and very injurious to the woodwork of buildings in Honolulu, has been discovered infesting the woodwork of floating docks and barges in the harbor. Since these vessels move from port to port every effort should be made to control the pest in Hawaii, and close inspections have been maintained so that this termite may be kept out of the continental United States.

INSECTS AFFECTING SHADE TREES AND HARDY SHRUBS

Excellent results have been obtained in the control of the boxwood leaf miner, conducted in cooperation with the bureau of plant industry of the Pennsylvania State Department of Agriculture. A mortality of 90 to 100

per cent has been obtained by means of hydrocyanic-acid-gas fumigation under tents, with little injury to the plants when the work is carefully done.

BEE-CULTURE INVESTIGATIONS

The work on bee culture has continued under the supervision of James I. Hambleton.

BEHAVIOR OF BEES

Work on the seasonal brood-rearing activity of colonies under normal conditions was continued and one paper was published outside of the department. The investigation of the brood-rearing activity of the leading races of honeybees was also continued, and one paper dealing with the brood-rearing activity of the Cyprian honeybee was submitted for publication by the department. A study of the brood-rearing activity of package bees during their building-up period, begun last year, was conducted on a larger scale to determine the rate of building-up of packages of various sizes and thus ascertain which size seems most economical from the building-up standpoint. A paper covering last year's work on package colonies has been submitted for publication.

Experiments dealing with the flight activities of bees have been continued, the work this year dealing particularly with methods which it is hoped will eliminate the stimulating effect upon flight brought about by the presence of nectar in the field, so that accurate information may be gained on the effects of weather factors alone.

In the experiments dealing with the reactions of bees to light the following three things have been experimentally ascertained: (1) The relative stimulating efficiency of light transmitted through certain chromatic filters has been worked out quantitatively. (2) By the use of the training method it has been found that bees can distinguish between two beams of light equal in radiant energy but diverse in wave length. (This is what would be expected from the first result mentioned, since two such beams evidently have a different stimulating effect.) (3) Conversely to (2), it has been found that bees can distinguish between two beams of light equal in wave length but diverse in radiant energy. It is hoped to ascertain whether or not bees can be trained to select light of any given wave length in the presence of light of any other wave length, regardless of relative intensity. Several factors in the learning process are also receiving attention in these experiments; for example, how long a training period is required for bees to learn various things, how long learning is retained, and what effect the age of the bee and the season of the year have on learning.

PHYSIOLOGY OF BEES

A study of bee mortality during the winter months has been carried on. The rate of mortality is being correlated with the various weather factors and with the known condition and age of bees at the start of the winter period. By these experiments it is hoped to obtain, if possible, some accurate data on the causes of enormous losses of bees sustained annually during the winter period. It is estimated that the average winter loss throughout the United States is at least 12 per cent, and cases of losses amounting to well over 50 per cent are not uncommon. In conjunction with the study of the mortality of adult bees during the winter period, the Amoeba disease of the honeybee was discovered in two of the colonies under observation. Microscopic studies were made of the organism in order definitely to establish its identity. It turns out to be the same organism that was recently discovered in Germany. A brief description of the appearance of the parasite in the Malpighian tubules was prepared and presented for publication outside of the department. In cooperation with the Bureau of Home Economics preliminary investigations on the vitamin content of honey have been completed. Vitamins A, B, C, and D were found lacking in samples of light and dark honeys which were fed to a series of rats on diets known to be lacking in these vitamins.

DISEASES OF BEES

Eight hundred and fifteen samples of brood and adult bees have been examined for brood diseases during the year. In the United States as a whole the bee-disease situation seems to remain about the same, judging from the samples received. All importations of adult bees from foreign countries have been found to be free of *Acarapis woodi*, the mite which is causing considerable damage in Europe. The diagnostic work has brought to light a number of cases of disease the cause of which has not been ascertained.

Studies of some of these diseases are being made, and during the last year work dealing with the pathogenic relations of the fungi with the honeybee have been continued. This work has shown that the most virulent strains are of the *Aspergillus flavus-oryzae* group with the most destructive organisms existing among the strains of *A. flavus*. In addition to an earlier report describing this work, a scale dealing with all the groups of the Aspergilli and showing the relative degree of virulence among the different groups is being prepared. A study has been begun dealing with the yeasts inhabiting the honeybee. The organism *Saccharomyces apiculatus*, which has been described in France as the causative organism of the disease known as May disease, has been found to be a common inhabitant of the honeybee in America. Tests thus far here fail to show that the organism is capable of causing disease among bees, but it is actively pathogenic within the blood of bees.

BEEKEEPING REGIONS IN THE UNITED STATES

Work carried on in cooperation with the Bureau of Agricultural Economics on United States standard grades for honey has been completed and the results published in Department Circular 410. Demonstrations in grading have been given by inspectors of that bureau and a circular of instructions on grading honey has been prepared for the use of its inspection service.

INTERMOUNTAIN BEEKEEPING METHODS

A beekeeping field station was established at Laramie, Wyo., in November to carry out investigations on problems dealing with beekeeping methods peculiar to the intermountain region. The University of Wyoming has provided laboratory and office space as well as a considerable quantity of special equipment for the use of this station. A portion of the winter and spring months was utilized in becoming familiar with beekeeping practices in the intermountain States and was occupied with the many details connected with the establishment of the laboratory and experimental apiaries. The plan of work during the first year has been primarily directed along two lines, one dealing with the spread of infectious bee diseases in commercial apiaries and the other with a study of the flight activities of bees under intermountain conditions. One series of experiments dealing with the latter phase of the work has already been completed.

INSECT-PEST SURVEY

J. A. Hyslop has continued in charge of the work on the insect-pest survey.

This survey has now functioned for six years and is recognized as an integral part of the cooperative work of the bureau and the entomological agencies existing in the several States and the Dominion of Canada.

During the year the survey completed volume 6 of its monthly bulletin, comprising 10 numbers and 321 pages of text material and an index of 41 pages. A second appendix to the list of common names approved by the American Association of Economic Entomologists was also issued during the year under the supervision of the insect-pest survey.

The project to incorporate in the files of the survey the statistical data on the economic insects of North America from the literature is well advanced and a similar project to incorporate in the files of this survey such data on insects of the world has been begun. The survey files now contain references to considerably over 2,000 species of insects of economic importance in North America and about 1,500 species in foreign countries.

During the year the survey inaugurated its first field investigation, namely, that relating to methods of estimating the abundance of the black scale in the citrus groves in southern California. This project has cleared up many points and has materially advanced the action and simplified the procedure of this work. A second project—estimating the abundance of the alfalfa weevil—was started in the alfalfa fields of the Great Basin in Utah. The necessary statistical data have been accumulated and are now being studied with a view to simplifying and testing the reliability of a method now in use for this purpose.

TAXONOMIC INVESTIGATIONS

The work done on the identification and classification of insects has continued under the supervision of S. A. Rohwer. As heretofore, it has been conducted in cooperation with the National Museum, where the specialists are given desk room and where they can conduct their investigations assisted by the extensive collections of the museum.

During the year 12,243 determinations were made by the specialists assigned to this unit. Approximately 48 per cent of these identifications were for the Federal Horticultural Board, 16 per cent for other offices of the Bureau of Entomology, and the remaining 36 per cent for other institutions or for individuals. About 40 per cent of the identifications made for institutions or individuals outside the department were for specialists associated with State experiment stations, and have thus served to advance the investigations on injurious and beneficial insects carried on by the States. The identification work of this unit is of a service nature and without it the enforcement of foreign quarantines and the research conducted by other offices of the bureau and by outside agencies would be greatly hampered.

Included in the material received for identification during the year were four lots of specimens collected on cotton plants in the Southwest. The specimens are to be used as evidence in court and were received under seal. The determinations and the report thereof were prepared in the presence of witnesses, the specimens returned under seal, and the report made under oath.

Besides supplying names for specimens submitted, certain of the specialists have had time to prepare for publication revisions of certain groups of insects. These revisions bring together the known information on the classification of the forms studied, and include descriptions of many species new to science. One of these revisions dealt with the American moths of the genus Diatraea, the group to which a number of injurious borers, such as the sugar-cane moth borer, belong. Another published study dealt with the larvae of weevils belonging to the genus Bruchus, and pointed out characters by which those species injurious to stored beans, peas, etc., can be distinguished. Still another pointed out diagnostic characters of the larvae and pupae of fruit flies occurring in this county or likely to be imported in fruits. A comprehensive study of the taxonomy of the beetles of the genus Agrilus has been nearly completed. This genus contains many species which feed in the larval stages in many kinds of ornamental shrubs and forest trees, and often cause considerable injury, reducing the vitality or causing the death of the plant. Besides the examples of revisionary papers cited above, many less comprehensive publications have been prepared in which many new forms have been described, and the names made available to investigators throughout the world.

U. S. GOVERNMENT PRINTING OFFICE : 1927

REPORT OF THE CHIEF OF THE OFFICE OF EXPERIMENT STATIONS

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., September 17, 1927.

SIR: I have the honor to submit herewith the report of the Office of Experiment Stations for the fiscal year ended June 30, 1927.

E. W. ALLEN, *Chief.*

Hon. WILLIAM M. JARDINE,
Secretary of Agriculture.

The work of the Office of Experiment Stations increased in volume and broadened in scope during the year with the expanding activities of the experiment stations.

In addition to administering the Hatch, Adams, and Purnell Acts; supervising the work of the agricultural experiment stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands; and reviewing the progress of agricultural research in the Experiment Station Record, the office developed various other ways of aiding in the promotion of the work of the stations, enlarging and to some extent reorganizing its force for this purpose.

There was continued expansion and development of research at the State agricultural experiment stations under the Federal appropriations. The supervisory duties of the Office of Experiment Stations were considerably enlarged as a result of the increase in appropriation under the Purnell Act, amounting to $480,000, and in this second year under that act a wide variety of administrative questions came up for attention. The attempt to develop more uniformly high standards for all research under the Federal funds has resulted in increasing advisory relations and in calls for assistance of various kinds.

FEDERAL AID TO STATE STATIONS

During the year the Federal appropriations in aid of the State experiment stations amounted to $2,880,000. Of this amount $1,440,000 resulted from the Hatch and Adams Acts of 1887 and 1906, respectively, and an equal amount from the Purnell Act of 1925. Each State received, therefore, $60,000 from the Government, an increase of $10,000 over the previous year, in accordance with the terms of the Purnell Act.

The office represented the department in the administration of these funds, which, in accordance with the Federal acts, are paid to the States quarterly on the warrant of the Secretary of Agriculture. Certification of the stations and the issue of these warrants are made on recommendation of the office. Fortunately it has not been necessary to withhold the issue of a quarterly warrant during the year, except temporarily in the case of Arizona. The local situation in this case became such as to menace the station affairs and the proper use of the Federal funds and to upset the department's relations with the institution to such an extent that the continuance of the quarterly advances was not considered justifiable. With the restoration of favorable conditions the funds were restored.

While many questions in regard to the administration and use of these Federal funds have arisen, in the main the supervision exercised has been in the nature of advice and suggestion, with the speedy correction of any doubtful procedure to which attention was called. There is, perhaps, no similar example of the administration of so large a public sum for research in any line, and the spirit in which it is met is a sign of the community

of interest and the desire to secure for the funds the highest practicable degree of productivity.

The administration of the Purnell fund has involved a variety of problems not directly associated with the character of individual projects. These have been of importance because of the establishment of policies relating to this growing fund, which as years go on will assume quite large proportions. The questions have resulted mainly from the effort to confine the use of this fund quite definitely to expenses connected with the approved investigations. The tendency to use the fund for administrative purposes, assessing upon it a part of the salary of the director and others connected with his office and with the accounting, has been strongly opposed. Furthermore, the use of the fund for capital expenditures relating to the plant, such as new buildings and land, has been combated as a matter of good policy in order to hold the expenditures to the needs of the investigations. In these and similar matters advice and appeal to the spirit of the Purnell Act have been relied upon, rather than strict interpretation of the act itself.

As the Purnell fund has grown, it has brought added obligations on the stations, but the policy has been to hold quite strictly to the original idea of regarding this appropriation as supplementary to those under the two previous acts and by the States, to be employed in carrying on additional investigation. The resulting growth of the stations has made inevitable some increased expenses on the part of the States, which in the main can be cared for by regular appropriations. The maintenance of these State appropriations without diminution has been a matter to which a good deal of attention has been given. It is gratifying to report that there has been little or no evidence of a disposition to use the Purnell fund for relieving the States of their obligations. This is indicated in a broad way by the fact that of the approximately $12,500,000 available during the year for the support of the stations over $9,000,000 was derived from sources within the States.

ADMINISTRATION AND SUPERVISION

The administration and supervision of the Federal funds by the office have been exercised through several channels. Projects for research in which Adams and Purnell funds are to be used are submitted in advance for scrutiny and acceptance before support is assigned them from these funds. In addition, the annual research programs and budgets are submitted and passed upon at the beginning of each fiscal year. This results in many revisions of standing projects to keep them up to date and often calls for reports of progress to enable judging of their course and advance. An annual visitation or inspection is made of each of the State stations by a representative of the office, in connection with which the work under the Federal and State funds is gone over, the finances examined, the general condition of the station considered, and various questions of policy and management taken up with the administrative officers. In addition to the examination of the accounts at the stations an annual financial report is made on each of the Federal funds by each institution, which is examined in the office with reference to its approval, or its modification if this is necessary.

During the year there were in active operation 465 research projects under the Adams fund and 788 under the Purnell fund. Some 275 new projects were passed upon and approved for these two funds. The keeping of records of this large number of research undertakings and dealing with the revisions and amendments necessary, the changes in personnel relating to them, and the assignment of funds for their support, including those from State sources, is in itself no small task. The supervision extends throughout the year, and attention is called to projects which are lagging and to those in which the approach and technic need strengthening.

The relation maintained to the Federal funds and their use in research is a close one and has been increasingly so with the coming of the latest appropriation. It has insured careful consideration of proposed investigations as to their merit and aims, not only at the beginning but at stated stages in their progress. Special attention has been given to the grade of the work, because it is a reasonable expectation that this will advance with the progress of research and that it will be of a character which will supplement or add to what has gone before. This imposes expectations as to the effectiveness of the technic, the progressive character of the investigation, and that it will conform to contemporaneous investigation and be definitely directed at objectives which

need further study. It serves to avoid duplication and repetition and to discriminate more sharply against pure demonstrations.

Any tendency to assign more projects to the Federal funds than there is adequate support for has been combated and, when there was question as to this support, the supplementary support from State sources has been inquired into. During the past year, particularly, the attempt has been made to have the budgets made on the project basis rather than on the basis of departments or groups of projects. This has proved generally practicable. It insures more definite consideration of the needs and financial requirements of separate undertakings and guards against attempting to carry too many independent lines.

Superficiality, especially in the newer lines of research, has been guarded against, including any tendency to conclude projects prematurely or before the study was reasonably complete. Much emphasis has been laid on thoroughness at this stage and, in individual cases, it has called for administrative attention. The office is thus endeavoring to function as an agency for constructive criticism in agricultural research. Its activities in that direction have been welcomed and encouraged by station administrative officers, and have insured an amount of consideration to new and going projects which is rarely accorded in any other field.

CHANGES IN ORGANIZATION

To meet the enlarged demands upon the office growing especially out of the Purnell Act, several additions were made to the administrative personnel. Specialists were provided for assistance in agricultural economics, home economics, soils and fertilizers, agricultural engineering, and animal husbandry and genetics; and the handling and recording of projects, budgets, cooperative enterprises, and the like, was more systematically organized.

Larger opportunity has been afforded for personal contacts between the office staff and station workers and other investigators by visits to the stations, attendance at meetings and conferences, and service on committees for specific purposes. It is believed that this will be to the mutual advantage of the office and the stations and will lead to better understanding and cooperation in the setting up of satisfactory projects and the advancing of research in general.

During the past year members of the staff have participated in conferences or presented papers dealing in a constructive way with planning and conducting feeding experiments, the judging of the quality and palatability of meats, the scope and character of investigations in home economics, the scope and purpose of experiments with cotton, horticultural research, investigations on certain diseases of animals, the development of programs and projects of research in agricultural engineering, and the improvement of methods of research in agricultural economics and sociology.

In propagating ideals and policies the office has worked in close contact with the Association of Land-Grant Colleges and Universities, the American Home Economics Association, the American Society of Agricultural Engineers, and other scientific organizations. Representatives of the office have had prominent part in these organizations, which have been found a very helpful means of extending the influence of the office and directing attention to standards, methods, and procedure.

RESEARCH PROJECTS

The total number of research projects in active operation at the stations during the year was 6,186, of which 465 were Adams projects and 788 Purnell projects. Thirty-five new Adams projects and 235 Purnell projects were passed upon and approved during the year. Outlines for many other proposals and numerous revisions of existing projects were dealt with.

Of the active Purnell projects, 39 dealt with soils and fertilizers, 11 with genetics, 43 with field crops, 10 with pastures and ranges, 50 with horticulture, 2 with forestry, 37 with plant diseases, 46 with entomology and zoology, 97 with animal production, 37 with dairying, 19 with animal diseases, 23 with engineering, 95 with home economics, 245 with agricultural economics, and 34 with rural sociology.

Research in agricultural economics has made remarkable growth in the two years since the Purnell Act went into effect. Probably no other department of station investigation ever had anything like as rapid and extensive development. Stations in all of the States except one have inaugurated work in this field, whereas in 1925 stations in only 29 States were so engaged. Of the 245 projects in agricultural economics active during the past year, 94 dealt with economics of

production, 112 with marketing, 29 with taxation, credit, land values, tenancy, and contracts, and 10 with miscellaneous subjects.

Home economics ranks next to agricultural economics in number of projects under the Purnell fund. While the larger proportion of these projects deals with foods and human nutrition, other features of the subject are being gradually developed. Among these are clothing and household management, and especially certain questions which affect the sociological status and welfare of the home.

There was some increase in projects in rural sociology, and substantial progress was made in developing the methods of research in this field. The efforts of investigators and organizations interested in promoting such research culminated during the year in an institute on research methods in rural sociology, held at Purdue University April 4 to 8, 1927, the primary purpose of which was to offer a definite program of developing the best ideas available as to the organization and conduct of research in this field, with specific reference to the work already under way or in contemplation. The office took an active part in encouraging and aiding these efforts.

COOPERATION IN RESEARCH

The office has been assigned the duty of keeping a complete record and file of cooperative agreements and projects for research between the department and the State experiment stations. By the terms of the Secretary's order the office is expected to be "represented in negotiations for cooperation between the department and the experiment stations, and will maintain a file of such cooperative agreements." Considerable attention has been required to inaugurate this system, and a good deal of time has been given to conferences on proposed cooperative undertakings, the volume of which is steadily increasing.

The office has maintained a close connection with the national cooperative projects set up by the stations when the Purnell fund first became available. A revision of the outlines for these projects has been prepared and issued by the office, and it has been represented on the joint committee on projects and correlation of research. The chairmen of the national projects have been kept informed of new projects in their respective fields, as well as of revisions and conclusions. In this way special effort has been made to improve and strengthen these cooperative undertakings and to assist the committees having them in charge.

INSULAR STATIONS

The appropriations for the experiment stations in the outlying possessions—Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands—are made directly to this department, to be spent under its immediate direction, and not assigned to the respective territories, as are those for the State experiment stations. In this respect the insular stations are Federal stations, established and maintained to serve the needs of their respective localities. The administration of these stations is assigned to this office, and Dr. Walter H. Evans has continued in charge of this branch of its work. Each station has a director who deals with the local administration.

The character of the work of these stations did not change materially during the year. All the station projects were revised. Some have been brought to a satisfactory conclusion, while others have had to be suspended on account of a lack of funds and insufficient personnel.

The support of these stations comes wholly from appropriations made by Congress, and the sums granted have not kept pace with the increased cost of operation. All of the stations are undermanned to carry on the work as it should be done. Many important investigations have had to be put aside through lack of equipment and men. The stations need additional buildings to house their work and employees. In most cases the present buildings were erected a good many years ago from the proceeds derived from the sale of products. This is no longer possible, and new buildings as well as repairs must come out of the current appropriations. The result has been that the station property has depreciated rapidly, and in some cases buildings are occupied that are not only unsuited to the purpose but are in danger of collapsing.

The Federal contributions to the State experiment stations for the year 1927 were 100 per cent greater than they were in 1924, while the income for the insular stations has been increased by only about 14 per cent. This situation has in some cases resulted in positive detriment to the work. The stations are earnestly striving to aid their constituents in

the solution of their problems, and they should be encouraged in their efforts.

The total incomes for the several stations for the fiscal year ended June 30, 1927, were: Alaska, $76,240; Hawaii, $54,940; Porto Rico, $56,460; Guam, $24,160; and Virgin Islands, $22,180. The proceeds from sales, amounting to $7,636, were deposited in the Treasury as miscellaneous receipts.

ALASKA STATIONS

The Alaska stations underwent some reorganization during the year. C. C. Georgeson, who had been in charge of the stations for nearly 30 years, and who had selected the site and planned the work for each station, was relieved of administrative duties on April 1, 1927, and H. W. Alberts was placed in charge. Doctor Georgeson has continued with the stations, however, and is engaged in compiling the results of the experimental work performed at the different stations.

Doctor Alberts is well equipped by training and experience for his new duties. He spent some time during the year visiting the Alaska stations and various parts of the Territory to familiarize himself with their agricultural possibilities and problems. In nearly every case he found marketing rather than production to be the limiting factor of agricultural development. In regions adjacent to local markets agricultural development has kept pace with the demand for products of the land, but where there are limited local markets or inadequate means of transportation to market progress has been very slow.

The work at the Alaska stations was not materially changed, and progressed about as formerly, with a favorable season and a very promising crop outlook.

The removal of the cattle, except a few of the breeding Galloways, from the Kodiak to the Matanuska station, as mentioned in last year's report, made too great a demand on the Matanuska station for feed and pasture, and it was found necessary to reduce the herd to the carrying capacity of the Matanuska station. The cross-breeding experiments with Yak and Galloway cattle at the Fairbanks station and Holstein-Galloway crosses at the Matanuska station were continued.

The Alaska stations are in serious need of more adequate equipment of buildings, laboratories, etc. The Fairbanks station is in need of a residence to take the place of a temporary log house, built in 1907, which is now scarcely habitable. An enlargement of the barn is needed to provide storage space for forage for the stock and an adequate place for caring for the material produced in the plant-breeding experiments. The Matanuska station needs a mess hall and rooming quarters for its laborers, a cottage for its assistant, and a laboratory and packing shed for the horticultural work. The greenhouse and horticultural workshop at Sitka were destroyed by fire on April 5, and a new structure is essential to continuing the plant-breeding and propagating work at this station.

Additional cleared land is needed at the Fairbanks and Matanuska stations if the work in plant breeding, crop rotation, and the production of forage for the increasing herds is to be continued.

The annual report was the only publication issued during the year.

HAWAII STATION

The Hawaii station continued to encourage the development of a number of minor agricultural and horticultural industries to supplement the sugar and pineapple industries, which are now the mainstay of the islands. Much of the land in the islands is not adapted to the two major crops, and it is believed that by diversifying the industries employment would be assured to many who are not now able or disposed to engage in agriculture on the plantation system.

The station has recently been particularly interested in the development of a starch industry based on the edible canna and in determining the possible value of edible canna as a rotation crop and a stock feed. The pigeon pea, introduced and improved by the station, has become a promising forage crop in Hawaii, and has been shown to be valuable as a rotation crop for improving the soil in cane and pineapple plantations. Efforts are being made to develop strains that will mature at the higher elevations of the islands. Superior varieties of tropical fruits, especially bananas and avocados, are being introduced and developed, and a large variety of horticultural plants is being distributed and widely tested. Attention is being given to improvement of field and pasture crops. Ginger has been introduced as a minor crop, and an attempt is being made to find a heading type of lettuce adapted to Hawaii conditions.

An effort is being made to establish strains of the hard-shelled avocados which shall be immune to attacks of the Mediterranean fruit fly, the pres-

ence of which in Hawaii has led to quarantine against the admission of the fresh fruit into California and elsewhere. As a part of the extension activities of the station, there were distributed 32,500 small plants and seeds of improved horticultural varieties of plants for testing by various cooperators.

The work of the extension agent on the island of Hawaii, the Haleakala demonstration farm on the island of Maui, and the boys' and girls' 4–H clubs was successfully carried forward and expanded during the year.

The Hawaii station is in need of an increased personnel to carry on its work. An additional chemist to perform the analytical work of the station and an assistant club leader to develop the club work among the rising generation are immediately required if the work is to develop as it should.

In addition to the annual report of the station, there were issued during the year Bulletin 55, Banana Culture in Hawaii; Bulletin 56, Carbohydrate Metabolism and Its Relation to Growth in the Edible Canna; and Extension Bulletin 10, Index to Publications of the Hawaii Agricultural Experiment Station, 1901–1926.

PORTO RICO STATION

During the year H. L. Van Volkenberg was appointed parasitologist to fill the position vacated by the transfer of the previous occupant to the Bureau of Animal Industry of this department. The new member of the staff entered actively on his work of studying the internal and external parasites of domestic animals and has found a number not previously known to occur in Porto Rico. A preliminary survey of the parasites of meat animals at a local public slaughterhouse has shown serious infestation of many animals.

The plant pathologist, C. M. Tucker, was absent for about half a year pursuing graduate work at the University of Missouri leading to the degree of doctor of philosophy. His major study while at the university was on phases developed in his investigations of the coconut bud rot. A new host plant, the Porto Rico hat palm, was reported for the organism causing the bud rot of the coconut palm. Considerable increase in coconut bud rot is reported, the new cases being attributed to injury to the developing bud tissues during the hurricane of July, 1926.

The study of root disease of citrus trees, which has assumed considerable importance in the large citrus-fruit area on the northern portion of the island, was actively pursued.

A study of forms of nitrogen in fertilizers for sugar cane was completed, and the results of experiments with fertilizers for coffee were published during the year. Progress was made in breeding experiments with corn and sugar cane and in the study of photoperiodism of economic plants such as onions, potatoes, corn, and pineapples. In the study of pineapple problems data were secured which appeared to explain the frequent failure of this fruit to produce profitable crops.

The Porto Rico station needs a chemist, an entomologist, and an animal husbandman. There are many problems awaiting such appointments and the station is equipped for all these departments, the positions having been previously filled but are now vacant.

The publications of the station consisted of an annual report and of Bulletin 31, Experiments with Fertilizers for Coffee in Porto Rico.

GUAM STATION

Conditions in Guam were unusually favorable for crop production. With the less rainfall during the usual rainy season, the precipitation throughout the balance of the year was such as to favor crop production. The uniform distribution of rain also tended to reduce insect depredations, especially by those which are favored by stunted plant growth due to drought.

The station continued to cooperate in many activities with the island government, especially with the insular department of education in its work in the graded schools.

The coconut-scale situation continued to receive attention and now appears to be well in hand. With the spread of parasitic and predacious enemies of the scale a balance has apparently been established and the threatened destruction of the coconut industry averted. A number of other insect problems, as well as plant and poultry diseases, received attention, as, for example, the attack of the Egyptian cotton worm on taro, the possible control of the red scale of citrus by an entomogenous fungus, damping off of corn, and fire blight and wasting disease of coconut palm. As a result of the station's recommendations, an executive order was issued by the governor requiring the destruction of all coconut trees affected by the wasting

disease. Studies were made of parasites of poultry, and the general presence of coccidiosis was revealed.

Improvement of horses and swine by use of purebred sires and experiments on the use of coconut meal as a feed for horses and swine were continued with good results. Extensive tests, in cooperation with the Government farm, of introduced forage crops were continued.

In the horticultural department the work consisted in caring for the orchards, plant introductions, propagation of tropical fruits, plant breeding and storage, and shipping experiments with oranges and tangerines.

The Guam station needs more men, equipment, and land. The present limited personnel can not adequately take care of the agronomy work. The extension activities that were so successfully inaugurated in 1919 but terminated in 1921 should be renewed. Club work among the school children is recognized as the best way to reach the adult population of the island. Governors of the island and the chamber of commerce have repeatedly recommended that this work should be taken up again.

The report of the station was the only publication issued during the year.

VIRGIN ISLANDS STATION

The rainfall in St. Croix during the year was 2 inches more than the 50-year average, and as a result crop prospects are very favorable. The labor situation in the islands continues to be acute, and many plantation laborers have migrated to New York City, attracted by the prospect of higher wages.

One of the important changes in the Virgin Islands station was the transfer of W. M. Perry, who had been horticulturist at the St. Croix station, to St. Thomas, where he is now serving as agricultural advisor and extension agent for the islands of St. Thomas and St. John. This change had been contemplated for some time, and was urged by the governor of the islands as well as many citizens. The two islands are but a few miles apart, but they are more than 40 miles from St. Croix, and transportation difficulties made it impossible for the people to keep in touch with the progress of the station on St. Croix and adopt the practices that are found advantageous. That the change was desirable is shown by reports of the activities carried on at St. Thomas and St. John. The transfer, however, left the St. Croix station without a horticulturist, and the already overburdened director had to assume leadership of the horticultural investigations.

During the year new roofs were placed on four of the station buildings and many minor repairs made, so that now the buildings are in fairly good condition, although several of them are old and poorly suited to station use.

Due to a threatened shortage of forage, the station reduced its herd of cattle by disposing of a number of native animals, keeping only the necessary work animals and a reduced number of native cows. The purebred animals were all kept, as well as the most promising of the grade calves. Milk records are being kept for all cows in production, and they will be used as a basis for a further reduction of the herd if that should become necessary. The poultry flock has been enlarged in order to get a record of the so-called native fowls as compared with Single-Comb White Leghorns. Preliminary data indicate that the Leghorns lay more and larger eggs, but the native stock is a little more hardy and better resists adverse conditions to which the fowls may be subjected.

The sweet-potato breeding work has been greatly reduced, because the director, who had it in charge, had to take over the work formerly conducted by the horticulturist.

The station repeated its experiments on the growing of eggplants, peppers, and tomatoes as winter vegetables for marketing in New York City, and two planters, induced by previous experiments of the station, grew Bermuda onions, peppers, eggplants, and tomatoes and sold the produce in New York City, with encouraging results. Without previous experience and with somewhat adverse soil and moisture conditions, the returns netted $150 per acre over all costs for rents, crop production, marketing, etc.

The station continued its work in developing new cane seedlings and the introduction and testing of other varieties, and some very promising ones have been secured.

The extension agent on St. Thomas and St. John was very active during the first year after taking up his new work. In addition to other activities he held 68 agricultural meetings and prepared 59 articles on agricultural topics for the local press. Garden clubs were organized throughout the islands, and seed of the best varieties of garden crops were distributed, with directions for planting and care of the crop. Agricultural clubs, with 131

members, were organized in various communities and monthly meetings held for the discussion of agricultural problems.

The Virgin Islands station is in need of a horticulturist to relieve the director of that work, and a veterinarian, who should also be an animal husbandman, to look after the livestock industry. Livestock production is second in importance to sugar production, and there is not a qualified veterinarian in the islands. When appointed, this man could look after the importation of livestock, so as to prevent the introduction of diseases. A campaign for the eradication of tuberculosis in cattle should also be undertaken, as that disease is quite prevalent among the people of the islands. The Governor of the Virgin Islands has most earnestly recommended the appointment of some one to look after the livestock industry.

The only publication of the station during the year was its annual report.

PUBLICATIONS AND INFORMATIONAL SERVICE

The publications of the office during the past year were, in the main, of the same character as in previous years. There was, however, some increase in special articles and papers prepared by different members of the staff and in bibliographic and informational service.

It is the purpose of the publications of the office to keep experiment-station workers and other investigators informed as to the progress of agricultural research throughout the world, to aid them in organizing and conducting such research, and to inform the public of such advances as are of general interest and concern.

The office issued during the year 37 documents aggregating 3,111 pages, as compared with 37 documents aggregating 3,424 pages the previous year. These included the usual numbers and indexes of Experiment Station Record, 11 publications of the insular stations, an administrative report on the work of the office for the year ended June 30, 1926, and a report on the work of the experiment stations for the year ended June 30, 1925.

EXPERIMENT STATION RECORD

The enlarged administrative program of the office led to considerable reallocation of duties, resulting in an unusual number of changes in the Record staff and a material reduction in the assistance rendered by several of the most experienced specialists. Three new specialists were added to the Record staff, and volumes 55 and 56 were prepared for publication without serious delay. These two volumes, each consisting of the usual nine numbers and index, contained a total of 7,062 abstracts, essentially the same number as in the previous year.

The policy of the Record was unchanged. The current scientific literature of the world pertaining to agriculture, aggregating over 400,000 pages, appearing in many languages, and scattered through hundreds of journals and other publications, was abstracted as completely as possible in the 1,631 printed pages available for the purpose. This material was supplemented by the customary monthly editorials, discussing the promotion of agricultural education and research and related questions, and brief notes in each issue on progress in this direction in this and foreign countries.

The literature to be abstracted continued to increase steadily, making the problem of an adequate review in the existing space limits more and more difficult of solution. The last enlargement of the Record was made in 1911, when 100 pages per volume were added. A similar expansion of at least 200 pages of abstracts annually appears to be inevitable in the near future if the full usefulness of the publication is to be maintained.

REPORTS ON THE WORK OF THE STATIONS

A report reviewing the progress of the stations: discussing administrative problems and relations of the office with the stations; giving information regarding personnel, projects, additions to buildings and equipment, and State legislation affecting the stations; and including a classified list of station publications and detailed statements of income and expenditures and other data was published. A similar report for 1926 was prepared and submitted for publication. Separates of articles entitled "Investigations on Tobacco, with Special Reference to Quality," by H. M. Steece: "Investigations on Bacillary White Diarrhea Infection of Fowls," by W. A. Hooker; and "Station Work on the Mechanics of Tillage," by R. W. Trullinger, in the report for 1925, were reprinted and distributed to those especially interested in their subject matter.

U. S. GOVERNMENT PRINTING OFFICE: 1927

DEC 1927

REPORT OF THE DIRECTOR OF THE EXTENSION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE,
EXTENSION SERVICE,
Washington, D. C., September 1, 1927.

SIR: I have the honor to present herewith the report of the Extension Service for the fiscal year ended June 30, 1927.

C. W. WARBURTON, *Director.*

Hon. W. M. JARDINE,
Secretary of Agriculture.

PERSONNEL

The personnel in Washington on June 30, 1927, consisted of 178 persons, of whom 5 were employed in the office of the director, 118 in the office of cooperative extension work, 28 in the office of exhibits, 20 in the office of motion pictures, and 7 in the office of agricultural instruction. The field force on the same date consisted of 4,010 persons, of whom 3,996 were cooperatively employed by the department and the States in extension activities. The 14 field workers not cooperatively employed included 2 persons employed by the office of demonstrations on reclamation projects, 3 full-time employees of the office of cooperative extension work, and 9 employees of the office of exhibits. In addition to the persons employed cooperatively by the department and the States, more than 1,050 were engaged in extension work in the States who are not under appointment from the department.

The only change in organization during the year was the consolidation of the office of agricultural instruction, formerly a detached unit, with the office of cooperative extension work. The consolidation was not made until near the close of the year, and therefore the report of the agricultural instruction work is presented separately herein.

FUNDS ADMINISTERED

The direct Federal appropriation for the Extension Service during the fiscal year was $1,640,568, of which $1,308,540 was for farmers' cooperative demonstration work, $143,643 for salaries and administrative expenses, $99,745 for exhibits, $38,640 for demonstrations on reclamation projects, and $50,000 for farm-forestry extension. In addition, Federal appropriations amounting to $5,880,000 were allotted to the States for extension work under the terms of the Smith-Lever and supplementary acts. The States, counties, and other agencies contributed $12,832,714 for cooperative extension work. The total of all of these items, the sum available for extension work in the United States during the fiscal year, was $20,353,282.

COOPERATIVE EXTENSION WORK

PERSONNEL

The personnel of the office of cooperative extension work during the year continued on practically the same basis, with C. B. Smith, chief, and J. A. Evans, assistant chief. On June 30, 1927, the Washington staff consisted of 10 administrative or supervisory officers, 13 organization field agents, and 12 subject-matter field agents, with a clerical staff of 83.

During the year F. P. Lund, specialist in food preservation, continued on indefinite furlough in Denmark at the request of the International Education Board. That phase of extension work formerly conducted by Doctor Lund has been discontinued. Harlan L. Shrader, formerly poultry specialist with the Missouri Extension Service, was selected as field agent in poultry husbandry and began work October 1,

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1926. Although the above figures indicate an increase of one in subject-matter field agents, there is actually no increase due to the absence of Doctor Lund.

J. A. Evans, who was furloughed beginning July 15, 1925, to study for the Portuguese Government the possibilities of cotton growing in the colonial possessions of that country in southeast Africa, returned to duty on October 1, 1926.

The entire State field staff on June 30, 1927, numbered 5,055 persons, an increase of 90 during the year. Of this number, 3,603 were permanently located in the counties, 2,263 being in county agent work, 910 in home demonstration work, 153 in boys' and girls' club work, and 277 in extension work with negroes. The county extension agents were supplemented in their work by 774 full-time and 203 part-time subject-matter specialists located at the State agricultural colleges. There were 414 supervisors and assistant supervisors, and the administrative officers and their immediate assistants numbered 61. These figures show an increase in the field staff of 90 county workers and 5 administrative and supervisory workers during the year, and a decrease of 5 subject-matter specialists. Of the total number of field workers, 3,996 were cooperative employees of the office, practically all engaged either in county extension work, supervision of county work, farm-management demonstrations, or farm-forestry extension.

FUNDS

The total funds from all sources available for cooperative extension work during the fiscal year were approximately $20,148,800, an increase of about $350,000 over the previous year. Of the total funds, 36.3 per cent, or $7,316,086, was contributed by the Federal Government, exclusive of the use of penalty envelopes, and 28.4 per cent, or $5,717,538, was derived from State appropriations to the agricultural colleges and other State agencies. The remaining 35.3 per cent, or $7,115,176, came from county appropriations for extension work and from contributions by local organizations and individuals. Approximately 95 per cent of all funds used for cooperative extension work in 1927 came from public sources.

Of the Federal funds, $5,880,000 was made available by the Smith-Lever Act and an appropriation supplementary thereto, $1,386,086 from direct appropriations, and $50,000 for cooperative farm forestry work. Of the total funds, $12,629,043 (62.7 per cent) was allotted for extension agents in the counties, $1,134,080 (5.6 per cent) was allotted at the State agricultural colleges for administration, $2,188,512 (10.9 per cent) for supervision of county extension workers, and $3,831,492 (19 per cent) for the employment of subject-matter specialists to supplement the county extension agents. The remaining 1.8 per cent, or $365,673, was for activities of the Federal Extension Service at Washington.

PROGRESS

RESULTS

Over 4,100,000 instances of the adoption of improved practices on the farms and in the farm homes of the United States in 1926[1] were reported. The increases over the previous year in the adoption of such practices were with soils, cereals, legumes, forage crops, horticultural crops, forestry, dairying, animal husbandry, rural engineering, rodent and insect control, agricultural economics, foods, nutrition, house furnishings, and home health and sanitation. Some decrease was noticed in the number of practices adopted relating to poultry and potato production, clothing, and home management. The progress made in influencing farm and farm-home practices during the year is attributed largely to the successful conduct of practical demonstrations by farmers and their families, and the effort made by extension agents to bring the results to wide public attention through meetings, tours, campaigns, the press, and other mediums. The aid given in the work by volunteer local leaders, of whom there were approximately 222,000, contributed materially to the success of the extension program.

Adult farmers and farm women conducted 644,784 result demonstrations in 1926, as compared with 772,469 demonstrations conducted by them in 1925. The number of demonstrations completed by farm boys and girls as members of 4–H clubs was 673,997 in 1926, as compared with 589,440 completed by them in 1925. Adult demonstrations increasing in number in 1926 over 1925 related to cereals, legumes, horticultural crops, forestry, animal

[1] All extension field reports are for the calendar year; hence figures contained in this report on cooperative extension work, except where the fiscal year is indicated, are for the year ended Dec. 31, 1926.

husbandry, and home health and sanitation. There was a decrease in the number of adult demonstrations in other lines of work. The increase in the number of demonstrations conducted by boys' and girls' 4–H club members was 84,557.

ADULT ACTIVITIES

Field crops, poultry, animal husbandry, horticulture, dairy husbandry, and soils, in the order given, were the leading lines of agricultural activity as gauged by the percentage of time devoted to them by extension agents. County extension agents in every State cooperated with local committees in studying the economic needs of their counties and helped to organize programs of work based on such needs in 31,422 communities. Particular emphasis was laid on conducting demonstrations suited to the practical needs of each community. In the marketing of farm products, county extension agents were reported as being of assistance to approximately 425,000 farm families and more than 3,000 cooperative associations. The latter did a business of $232,000,000 at an estimated saving to farmers of $16,000,000.

Of the lines of work relating to the farm home, clothing, foods, nutrition, house furnishing, home management, and home health and sanitation received the attention of extension agents and specialists in the order given. County home demonstration agents reported 319,217 adult demonstrations in such activities as being conducted under their direction. Of the 1,000 home demonstration agents reporting, 879 were assisted in their efforts by 49,166 adult voluntary local leaders. Home demonstration agents reported 14,800 community clubs with 285,221 members, through association with which their influence was extended materially. In 1926 the number of farm women organized into community groups to take advantage of extension work increased, a larger number of the demonstrations undertaken by farm women were completed, more efficient local leadership was developed, and agents and specialists used improved teaching methods more widely.

4–H CLUB ACTIVITIES

In 1926 there were 586,156 farm boys and girls enrolled as 4–H club members. Of the number 368,305, or 62.8 per cent, completed one or more result demonstrations. The number of boys and girls enrolled in 1926 was 21,000 greater than in the previous year. About 39,000 more boys and girls completed the work outlined in 1926 than in 1925. The number of demonstrations started was greater in 1926 by 81,000, and the number of demonstrations completed was greater by more than 84,000 than in 1925. These club members were enrolled in 41,234 local clubs, in the training of which the paid extension agents were assisted by 48,899 volunteer local leaders. Extension agents reported training 13,508 teams of club members to give public method demonstrations as a means of influencing more people to adopt the practices demonstrated.

In 1926, 4–H club members cultivated and owned 80,306 acres of corn, cotton, potatoes, and other field, truck, and orchard crops; 87,027 head of high-quality livestock; and 1,329,200 standard-bred fowls. They put up 2,638,023 jars of canned fruits and jellies and made 450,837 garments, in addition to carrying on numerous demonstrations in food preparation, house furnishing, home management, home health and sanitation, and the beautification of home grounds.

A significant national development in club work was the holding of a national 4–H club camp and conference of representative club members and State club leaders and their assistants in Washington in June, 1927. Two boys and two girls from each State, accompanied by two State leaders or assistant leaders, were invited to attend. There were 40 States represented at the conference, those not sending representatives being States in the far West. The program of the camp and conference consisted of leadership training, conferences on club problems, visits to the various departments of the Government, educational trips about Washington, inspirational addresses by prominent speakers, and recreation.

A western interstate camp called Camp Plummer was opened at Portland, Oreg., in the fall of 1926 as a center for interstate club activities in the Western States.

The club movement has been given further national impetus by the publication of the Boys' and Girls' 4–H Club Leader, a mimeographed house organ for club workers which has been issued monthly to extension agents by the office of cooperative extension work since January 1, 1927.

EMERGENCY ACTIVITIES

Extension workers gave prompt and effective aid in several serious emer-

gency situations which arose in various sections of the country during the year. The sharp reduction in the price of cotton in the early fall of 1926 led to the adoption of a program to lessen the acute financial distress of cotton farmers: Reduction in the cotton acreage; the increase of acreage in feed crops, chiefly corn and soy beans; the production of cash crops other than cotton, and the home growing of a larger quantity of the food consumed by the farm family were emphasized for 1927. The fall seeding of oats and wheat in sections where this is practicable was urged as an immediate relief measure. As a result, the acreage of fall-seeded oats and wheat and of corn and soy beans in the spring was increased extensively, and a considerable decrease in the cotton acreage was reported. Farmers in the Cotton Belt increased their holdings of dairy cattle and poultry as a means of supplementing their cash income. Potatoes, sweet potatoes, and truck crops were grown more extensively in sections to which they were adapted. Regular extension efforts to encourage home production of the farm family-food supply such as vegetables, fruits, milk, butter, eggs, and poultry were effectively stimulated. In the western section of the Cotton Belt there was a trend toward increasing herds of beef cattle and the growing of wheat and kafir. The safe-farming program long advocated by southern extension workers was advanced materially by the cotton situation during the year.

The threat of the European corn borer to the corn crop in the Corn Belt States was emphasized by an increase of 50 per cent in the area infested in the Great Lakes region in 1926. As a result Congress appropriated $10,000,000 to enable the department to cooperate with farmers and State agencies in the infested area in controlling the borer in an intensive large-scale campaign. The department extension service and the State extension divisions of New York, Pennsylvania, Ohio, Michigan, and Indiana were called on to handle the educational features of the campaign, the enforcement phases of the campaign being handled by the State departments of agriculture cooperating with the department Bureau of Entomology. The educational phases included the holding of field meetings and demonstrations, the preparation and distribution of publications, posters, motion pictures, lantern slides, and exhibits, and the maintenance of an effective news service to all daily and weekly papers in the area. This work was carried on in 82 counties in the 5 States. The burden of the campaign was carried by the county agricultural agents in these counties, assisted by the regular staff of extension entomologists, agricultural engineers, editors, and supervisory officials. When needed, these workers were supplemented by temporary personnel for the duration of the spring campaign. The temporary personnel included assistant county agents, who arranged and held the field demonstrations and meetings and answered inquiries regarding control measures. In a number of counties where assistant agents were not employed temporary clerical help was supplied to aid the regular agent in the distribution of publications, letters, and other educational material to the farmers. The temporary personnel was carried for the most part from March 15 to May 15, which was the period of intensive educational effort in the spring campaign. The object of the educational campaign was to obtain the largest possible amount of voluntary cooperation from farmers in carrying out the control measures, and it is estimated that 90 per cent of the farmers voluntarily carried out the control measures required of them.

In September, several Florida counties were laid waste by a hurricane, and their crop prospects for the year were ruined. The department, cooperating with the State college of agriculture, promptly instituted relief measures. The loan of funds was arranged for the purchase of seeds and supplies. County extension agents, both men and women, in the devastated counties were active in aiding the farmers to reestablish themselves and in encouraging the planting of gardens and the developing of quick sources of home-grown food supplies.

Flood conditions in the lower Mississippi valley called out all the resources of the extension organization. Mississippi, Louisiana, Arkansas, and Missouri were the States most seriously affected, although similar conditions prevailed in parts of Tennessee, Kentucky, and Illinois. For several weeks all extension effort in the first four States named was concentrated in aiding the farm population. The extension organization cooperated closely with the Red Cross committees and the people in the threatened areas in strengthening the levees, aiding in the evacuation of flooding territory, and in obtaining supplies for refugee camps. When the waters began to recede the county extension agents were active in

aiding in the replanting of crops and the rehabilitation of homes. The needs of farmers for seed, livestock, poultry, and supplies were determined, and arrangements were made with the Red Cross to finance such needs as far as possible. The home demonstration agents were active in aiding the women to take proper sanitary measures in reopening their homes and in making the home-grown food supply available as soon as possible. Through the home demonstration agents large supplies of canned fruits and vegetables and other food supplies given by farm families in counties outside the flood area were made available and distributed where they would do the most good. The return of the floods in some areas necessitating planting twice and in some cases three times, added to the difficulty and discouragement of both farm families and extension agents. The flood situation and the other emergencies which arose during the year tested the extension organization and were met by it effectively. They greatly strengthened the position of the county extension agent as an aid to farmers and their families in meeting constantly changing agricultural conditions.

EXTENSION STUDIES

This unit of the office is concerned with making investigations of various phases of extension activities as they are carried on by extension agents in the counties; with the collection, summarization, and digest of reports from State and county agents; with farmers' institute activities; and with the compilation and study of data regarding extension work carried on in foreign countries. M. C. Wilson continued in charge of extension studies.

FIELD STUDIES

Field studies of extension work were conducted in five additional States during the year. In Illinois, Pennsylvania, and Minnesota the studies relate to the general effectiveness of extension methods in influencing the adoption of better practices by farmers and farm women. In New Jersey a study was made of dairy extension work. In Minnesota and Wisconsin information was obtained regarding the effectiveness of bulletin distribution.

A total of 2,525 farm and home records was obtained and summarized during the year. Sixty-five additional members of the State extension services received training in the survey method of studying extension accomplishments.

Reports were prepared during the year on the studies made in Illinois, New Jersey, Pennsylvania, South Dakota, and Wisconsin. The following publications based on data gathered during field studies were issued by the office and cooperating State extension divisions: Extension Service Circular 33, Local Leadership and the Effectiveness of Extension Work in Reaching Rural People, and Wisconsin Extension Bulletin 387, Make Extension More Effective.

Considerable time and study were also devoted to further analysis of accumulated data and the preparation of the manuscript for a new department bulletin setting forth the relative values of the various means and agencies employed in extension teaching. The influence of subject matter upon choice and effectiveness of methods has been traced, and comparison has been made between the amount of time devoted to the various methods and the returns from each method as indicated by the information supplied by farmers and farm women on more than 8,000 farms.

For the first time scientific data are available in sufficient volume to replace or corroborate the current opinions regarding the relative effectiveness of the various methods employed in the conduct of extension work. Further studies may somewhat modify the conclusions drawn, but it is believed that the studies made to date in 33 counties of 13 States, involving nearly 12,000 different farms and homes, may be profitably used by extension workers and others interested in extension progress.

The results of field studies were presented at annual conferences of extension workers in Connecticut, Illinois, Kentucky, Nebraska, Pennsylvania, and Vermont.

The report on the use of demonstrations in extension work, prepared by W. J. Wright, following the study made in 1926, met with general approval. This study has done much to bring about a more precise use of the term "demonstration" in connection with all extension reporting.

SUMMARY AND DIGEST OF REPORTS

The reports received from approximately 4,000 State and county extension agents giving results obtained during the calendar year 1926 were assembled, indexed, and analyzed. A statistical summary of these results

was compiled and issued as Extension Service Circular 42, Statistical Results of Cooperative Extension Work, 1926. Four additional States assumed responsibility for summarization of the figures in the reports of their county extension agents. Detailed State summaries were prepared by the section for the remaining 12 States.

Numerous digests of narrative reports of State and county extension agents and subject-matter specialists were prepared during the year. Nine of these digests were published as mimeographed circulars and distributed to State and county workers. They covered the following subjects: Swine sanitation, marketing activities of farm women and girls, poultry housing, alfalfa, house furnishings, kitchen arrangement, clothing construction, copper-carbonate treatment of stinking smut of wheat, and potato spraying. These digests were appreciated by field workers who were thus brought into contact with the experience of other extension workers in the United States.

FARMERS' INSTITUTES

Twelve States reported the holding of farmers' institutes during the fiscal year ended June 30, 1926, or four fewer States than in 1925. In these States 2,849 institutes were conducted with 8,812 sessions, extending over 3,995 days, and a total attendance of 1,162,620 persons. In nine States the institutes were conducted by the college of agriculture or a special farmers' institute agency. Information regarding farmers' institutes during 1926 and on extension activities carried on in foreign countries was collected and compiled by J. M. Stedman.

VISUAL INSTRUCTION AND PUBLICATIONS

Activities of the office relating to visual instruction, publications, press material, radio, photographs, lantern slides, charts, motion pictures, and exhibits were conducted under the direction of Reuben Brigham, in charge of visual instruction and editorial work. Main developments of the year were the greatly increased use of field photographs in the news service; an increase in the demand for taking field photographs; the large output of art work; and the development of the new slide service in motion-picture film. The duplicating work of the office increased 60 per cent over the work of the previous year.

PUBLICATIONS

The printed publications prepared in the office of cooperative extension work and issued during the fiscal year were as follows:

Department Circulars: 385, How to Prepare and Display Extension Exhibits; 399, Home Demonstration Work, 1923. Miscellaneous Circulars: 72, A Decade of Negro Extension Work, 1914–1924; 77, Boys' and Girls' 4–H Club Work; 85, Boys' and Girls' 4–H Club Work, 1914–1924; 106, Emergency Crops for Flooded Lands in the Mississippi Valley.

The following contributions were made by the staff to the series of mimeographed extension service circulars: 14, Growth work with 4–H clubs; 15, The older girl in the extension program; 16, Games for 4–H clubs—tag games; 17, County agent standards; 18, Extension work in agronomy, 1925; 19, Some fundamentals of extension teaching; 20, Agricultural extension work in the 11 Western States; 21, County agent supervision; 22, Swine sanitation—excerpts from 1925 State and annual reports of county extension agents; 23, Foreign agricultural extension activities; 24, Marketing activities—farm women and girls; 25, Poultry housing—excerpts from 1925 annual reports of State and county extension agents; 26, A study of demonstrations as used in cooperative extension work; 27, Ten years of home management in the extension program; 28, Alfalfa—excerpts from 1925 annual reports of State and county extension agents; 29, House furnishings—excerpts from 1925 annual reports of State and county extension agents; 30, Kitchen arrangement—excerpts from 1925 annual reports of State and county extension agents; 31, Some factors affecting tenure in extension work; 32, Summary of distinctive features of 1925 home demonstration reports of the 11 Western States; 33, Local leadership and the effectiveness of extension work in reaching rural people; 34, Clothing construction—excerpts from 1926 annual reports of State and county extension agents; 35, Foreign agricultural extension activities; 36, Practice of forestry upon private lands as influenced by forestry extension; 37, Training 4–H leadership; 38, Developments in negro extension work; 39, Farmers' institutes, 1926; 40, Copper-carbonate treatment for stinking smut of wheat—excerpts from 1926 annual reports of county extension agents; 41, Feed resources; 42, Statistical re-

sults of cooperative extension work, 1926; 43, Extension projects in rural community organization; 44, Foreign agricultural extension activities; 45, Potato spraying—excerpts from 1926 annual reports of county extension agents; 46, Attitudes and problems of farm youth; 47, Summary of information—clothing project, 1926.

There were 13,208 requests for department publications from extension workers filled in cooperation with the Office of Information. The duplicating work of the office increased 60 per cent over the previous year. A total of 704 jobs were mimeographed involving 700,015 copies. Among the mimeographed jobs were the first six issues of the Boys' and Girls' 4–H Club Leader and 14 issues of the emergency house organ of the spring corn-borer campaign, With the Corn Borer.

The section handled the preparation for publication of the emergency printed material supplied by the department to extension agents in the States cooperating in the spring corn-borer campaign. These included an illustrated poster, a series of 12 cloth charts, cards for distribution at meetings or by mail, and wind-shield and letterhead stickers.

INFORMATION SERVICE

News material relating to national and regional results and developments in extension work was collected and made available for the daily and weekly press, farm papers, magazines, and news services. The special service in news photographs illustrating extension activities was expanded further, 2,301 photographs, accompanied by explanatory data, being supplied to special writers and representatives of news agencies.

In cooperation with the department press service, the section prepared 301 articles relating to various phases of extension work for use in the Official Record, department clip sheet, mimeographed release, and other channels.

An outstanding feature of the year's work was the handling by the section of the department's contribution to the special information service of the spring corn-borer control campaign conducted in cooperation with the State extension divisions and the State departments of agriculture. In each State an intensive news service under the direction of the extension editor was maintained and in four of the five States cooperating special field assistants in information were provided. The information activities in the States were coordinated with those of the department through the section of visual instruction and editorial work. The department contributed a cut and a mat service to the weekly and daily press in the campaign area, using photographs staged and taken by the section.

VISUAL INSTRUCTION

Talks on photography and the preparation and use of visual material were given at the request of State extension divisions at conferences in 13 States as follows: Colorado, Iowa, Kansas, Massachusetts, Montana, Nevada, New Hampshire, New York, Oregon, South Dakota, Utah, and Wyoming. These talks were followed by practical demonstrations and discussions of material submitted by extension workers.

PHOTOGRAPHIC SERVICE

Field photographs illustrating extension work for use in publications, press material, and exhibits, and for use at meetings as lantern slides were planned and taken in cooperation with 10 State extension divisions. The States in which photographs were made were Colorado, Georgia, Massachusetts, Michigan, New Hampshire, North Carolina, Pennsylvania, South Carolina, Virginia, and West Virginia, 2,804 new field photographs being obtained.

The photographic reference file of the section, which includes illustrations on a wide variety of agricultural and home-economics subjects, is kept in constant use by department and field personnel. The file at the end of the year included 31,230 photographs, of which 2,599 were added during the year.

Approximately 53,000 negatives, prints, slides, enlargements, charts, posters, and drawings were prepared for use in extension work. Requests for the preparation of illustrative material submitted by this section to the Office of Information and filled by that office included 3,933 negatives, 34,292 prints, 14,022 slides, 419 enlargements, and 408 miscellaneous items. In the section, 6,679 lantern slides and 279 enlargements, posters, and photographs were colored, and 997 charts, drawings, and designs were prepared.

A set of educational posters was worked out in cooperation with the Bureau of Home Economics illustrating the function of working centers in the farm kitchen for raw-food

preparation, cooking, sewing, and clearing away. A large number of special drawings and designs were also made for use in lantern-slide series on fabric selection, clothing selection and design, and window curtaining.

LANTERN SLIDES

There were 1,800 sets of glass lantern slides and 103 slide series on film lent to State extension divisions during the year.

The office cooperated with subject-matter bureaus of the department in preparing 21 series of glass lantern slides for the use of extension workers during the year, as follows: Series 35, Soy beans, culture and uses; 162, Care of horses' feet; 163, Cooperative bull association; 201, Eradication of tuberculosis from livestock and poultry; 202, Veterinary activities of the Bureau of Animal Industry; 204, Control of stinking smut or bunt of wheat; 206, Legume inoculation; 209, First aid in window curtaining; 210, Testing farm seed; 211, Cooperative marketing of cotton; 212, Be your own best exhibit; 213, Rounding out the four-leaf clover; 214, Cooperative marketing of burley tobacco; 215, Market classes of mules; 216, Forest planting in the Northeastern States; 217, Cooperative marketing in the United States; 218, 4–H Forestry club work in New Hampshire; 219, Windbreak or shelter-belt planting; 220, Some breeds of dogs; 221, Control of mosaic disease of cucumber; 222, Fur animals.

The section continued the preparation of new lantern-slide series on motion-picture film, which service was begun May 1, 1926. The following 36 series were added to the loan collection of the office: 20, The production of alfalfa east of the ninety-fifth meridian; 24, Leguminous forage crops for the South; 25, Leguminous forage crops for the North; 34, Green manuring; 103, The wheat crop; 104, The farm water supply; 105, Farm sanitation; 108, The European corn borer; 114, Farm forestry in the South; 126, Selecting the laying hen; 131, Farm manures; 133, Standard breeds of poultry; 141, Breeds of sheep; 142, Judging hogs; 147, Control and reparation of gullies; 150, How to get rid of rats; 151, The anatomy of the honey bee; 156, Analyze your business; 158, Quack grass; 159, Plant propagation; 160, Handling cotton; 165, The nature of plant diseases; 166, Cotton-boll weevil control; 167, Transferring bees to modern hives; 174, Milk in the home; 178, Better cotton on fewer acres; 179, Lime and limestone; 184, 4–H camps; 189, Plumbing in the farm home; 190, Food makes a difference; 196, Clover production; 203, Handling rough rice to produce high grades; 211, Cooperative marketing of cotton; 214, Cooperative marketing of burley tobacco; 216, Forest planting in the Northeastern States. In addition, the office cooperated with three State extension divisions in the experimental preparation of three special series for local use.

EXHIBITS AND MOTION PICTURES

In cooperation with the office of exhibits extension material was prepared for the interstate boys' and girls' club exhibit at Sioux City, Iowa.

In cooperation with the office of motion pictures, three extension motion-picture films were produced for distribution among extension agents and others, as follows: The Family Goes to College, Mother Takes a Vacation, and The Club, College, Farm, and Home.

RADIO

In cooperation with the radio service and the Bureau of Agricultural Economics a study was made of the use and value of radio to farmers and the extent to which they are interested. A questionnaire was sent to all county agents, of which 899, or approximately 40 per cent, were returned. A study of these questionnaires indicates that there is a considerable increase in interest and knowledge of the uses of radio on the part of county agents and farmers. County agents aided in directing attention to the value of radio in farm life by obtaining for farmers information about programs and schedules and by obtaining the cooperation of local radio dealers in supplying farmers with good equipment and taking care of their service needs.

Of the 899 county agents returning questionnaires, 438 had radio sets at home or in the office. They estimated that 431,480 sets were owned by farmers in the counties reported, or an average of 480 per county. This average is more than double the average of 204 reported in 1925, when the last survey was made. From these figures the radio service estimated that a total of 1,252,126 sets were owned and operated by farmers in the United States or practically two and one-half times as many as in 1925. This indicates that one in every four farms is equipped with a radio set.

SUBJECT-MATTER SPECIALISTS

A poultry husbandman was added to the corps of subject-matter extension workers during the year, bringing the number to 12. The work continued under the general charge of A. B. Graham.

The subject-matter extension specialists, in cooperation with the investigational forces of the bureaus, organized the research data of the several bureaus into form for use by the State extension forces and determined the means and agencies by which such data could best be disseminated. Five members of the staff prepared mimeographed periodicals entitled "The Extension Pathologist," "The Extension Animal Husbandman," "The Extension Horticulturist," "Farm-Management Demonstration Notes," and "The Extension Agricultural Engineer's News Letter," which set forth the methods advocated by the department and those in use by State specialists. One member of the staff prepared material for the Forest Worker, the house organ of the Forest Service. By these and other means the best extension methods were made available to all workers.

The specialists also reviewed all projects submitted by the States which related to their particular lines of work. In their visits to the States they studied and observed extension methods, agencies, and plans. Where funds were not yet available to employ a subject-matter specialist, certain persons within the bureaus were designated to give particular attention to plans, surveys, and reports of extension work related to their bureau activities. Special cooperation in the grading of livestock was carried on during the year with the Bureau of Agricultural Economics, and a specialist employed for the purpose visited many States in the interest of livestock grading.

This unit cooperated with the office of exhibits and the office of motion pictures in the preparation of exhibits and motion-picture films for the extension field. Three members of the staff devoted the major portion of the final three months of the year to field work in connection with the campaign to control the European corn borer. Another member contributed largely to the development of methods for the control of stinking smut in wheat.

About 975 part-time or full-time subject-matter extension specialists were employed by the States, as follows: Agricultural engineering, 44; agronomy, 105; animal husbandry, including veterinary, 99; clothing and millinery, 59; dairying, 82; entomology, including apiculture, 38; farm management, 45; foods, nutrition, and health, 65; forestry, 38; home management and house furnishings, 36; horticulture and pomology, 87; rodent control, 4; rural organization and marketing, 59; plant pathology, 24; poultry, 88; visual instruction, 11; publicity, 58; and extension schools, 34.

AGRONOMY

The important phases of agronomy extension varied little from previous years, according to the reports of the extension directors and agronomy specialists. Crop-extension activities centered largely in a continuation of the seed-improvement and standardization program and in the production of feed and pasture crops. Extension agents aided materially in promoting the growing of varieties best adapted to various localities, in the standardization of a few of the best varieties, and in the development of sources of high-quality seed primarily for use in the community and county in which it was grown.

Probably no phase of the extension program in agronomy was more important than that devoted to the growing at home of a sufficient supply of hay and roughage and, so far as possible, grain for feeding the livestock. The most popular and probably the most important legume crop during the year was alfalfa. That it is taking its place as a standard crop on a much larger number of farms is indicated by the fact that 57,638 farmers were reported as having adopted improved practices in the production of alfalfa. Work with soy beans was next in importance during the year, and sweet clover, cowpeas, velvet beans, and peanuts occupied a considerable amount of the agent's time in many counties.

Prominent among the activities of extension workers during the year was the development in the Southern States of a permanent feed program. A committee appointed at the conference of southern agricultural workers at Atlanta, Ga., in February, 1927, worked out a suggested feed program covering forage crops, grain feeds, and pasture for each of the various regions of the South.

Pasture improvement also received considerable emphasis, especially in the rebuilding of old pastures in rough, hilly sections, and in New England and the Middle West. In the Western States considerable time was devoted

to carrying on extension work in the rebuilding and reseeding of the open range and in the development of irrigated pastures and high mountain-valley pastures.

In soil improvement reports indicate a slowly growing interest on the part of county agents and specialists. The greatest amount of work was done in increasing the use of legumes, green-manure crops, and lime, and in teaching farmers the value of using high-analysis fertilizers. Specialists devoted much effort to the development of economical sources of limestone and methods of handling and storing lime to make it more easily available to the farmer.

HORTICULTURE

The general lines of horticultural extension carried on during the year were practically the same as in 1926. The standardization of commercial varieties of fruits received considerable impetus. Gardening activities increased, particularly in the South, where "year-round" gardens were encouraged. Disease control in the home orchard continued to be popular. By the proper use of sprays, trees which had been neglected for years were made assets to the farm. Pruning, fruit thinning, top grafting, soil management, and the use of cover crops and fertilizers were emphasized by county extension agents. As a result, 26,422 farmers pruned and 26,738 farmers sprayed their fruit trees for the first time. Orchard spray rings, which have proved to be very effective in the control of disease and insect pests, continued to grow in popularity.

In small-fruit culture, extension horticulturists demonstrated the advantage of using disease-free planting from which to grow healthy plants. Market and home gardens gained in importance. Extension workers increased their efforts to solve the problems of obtaining better strains of seed, of grading and preparing products for market, and of controlling diseases and pests. Other lines of service given vegetable growers by specialists and county extension agents included advice and demonstrations in the maintenance of soil fertility under a diminishing manure supply, the economical use of fertilizers, and marketing cooperatively.

Through giving demonstrations in the planting of lawns, flowers, shade trees, and shrubbery about the house, landscape specialists and county extension agents helped 59,912 farm men and women to beautify their home surroundings. In Florida native shrubbery and fruit and pecan trees were planted for use and beauty. Georgia and Texas held home-beautifying contests, and Missouri held 38 training schools, at which 161 local leaders were instructed in the principles of beautifying home surroundings. Parks and grounds about schools, churches, courthouses, and other public buildings were improved; houses and farm buildings and fences were painted; trellises were repaired; and unsightly spots around the home were removed through the efforts of extension workers.

FORESTRY

Forest planting, windbreak or shelter-belt planting, woodland management, timber estimating, and forest protection were prominent in the activities of extension foresters and county extension agents in 30 States during the year. Forestry planting on land not needed for agricultural crops continued to be the leading activity. During the calendar year 1926, 3,872 planting demonstrations, involving a combined area of 23,422 acres, were reported. Maryland, Michigan, New York, Ohio, and Pennsylvania reported the greatest accomplishments in this project. These States maintained State nurseries and developed effective plans for the distribution of tree stock. The promotion of the project was encouraged by carefully prepared planting programs in several counties. These programs set forth the need of planting in relation to the land problems of the particular county, contained recommendations of the kinds of trees to plant and their sources, set a goal, and outlined a plan for arousing public interest in forest planting. The demonstrations of planting were preceded and supported by meetings, news articles, contests, and circular letters.

Effective work was also done in the establishment of windbreaks on farms to protect homesteads and crops. Wide interest was manifested in this work even in the East and South where natural groves of trees already exist. Extension workers reported that 1,679 farmers planted windbreaks for the protection of their farms.

The development and improvement of existing stands of small trees or timber were encouraged through demonstrations in thinning and cutting. Nearly every State carrying on forestry extension reported work of this nature, which resulted in the growth of trees being stimulated in 3,412 farm woods covering a total of 111,668 acres.

In an effort to teach farmers to know the merchantable contents of their timber, extension foresters and county extension agents carried on demonstrations designed to show the farmer how to estimate with reasonable accuracy the value and amount of his woodland products. The Northeastern States in particular accomplished considerable results in measuring farm timber through the use of a cruising stick. Maine reported 75 meetings, attended by 892 persons, of whom 675 took active part in the demonstrations and measured 2,426 acres of woodland.

Conservation of the timber supply through forest planting, the preservation of fence posts, marketing of forest products, and the control of white-pine blister rust were also activities receiving the increasing attention of extension workers.

PLANT PATHOLOGY

The control of plant diseases, an essential feature of farming efficiency, was emphasized in practically every State during the year. Active service was given and demonstrations carried on in introducing or improving disease-control practices affecting more than 30 important crops. Of these practices the results obtained through advocating the use of the copper-carbonate treatment to control stinking smut of wheat were significant. A total of 38,640 farmers in 41 States treated their seed wheat for smut as a result of extension effort. The spray service to commercial and home orchardists and to truck-crop growers was improved and extended. Spraying and dusting were important control measures about which extension pathologists and agents gave much-needed advice, especially on the choice of the spray mixture and time of application.

Most of the States maintaining plant-pathology projects conducted, in cooperation with the plant-disease survey of the United States Department of Agriculture, a survey designed to anticipate and prevent unnecessary outbreaks of disease. Extension pathologists in combating disease and to reduce losses advocated the following methods: Quarantine, eradication of diseased plants or parts of plants and of alternate hosts which carry disease, selection of disease-resistant varieties and disease-free seed, crop rotation, seed treatment, treatment of wounds, fruits, and soils, spraying, and dusting.

Outstanding work was continued in teaching the farmers the value of using disease-resistant varieties of potatoes, asparagus, cabbage, tomatoes, and other plants. As a result of this work improved or certified potato seed was planted on 29,946 farms in the 48 States.

Most conspicuous progress was made in plant-pathology extension, not only in proving the worth of certain practices but also in developing methods of carrying such practices to the farmers in a manner that would bring about their more general adoption.

ANIMAL HUSBANDRY

Further improvement in the general livestock situation was reflected by the progress made in animal husbandry extension during the year, especially in work with dairy cattle, sheep, and swine. A larger share of attention was given to the solution of fundamental problems and long-time constructive projects than has been possible since the agricultural depression in 1920. Rapid strides were made in the more efficient organization of animal-husbandry forces and in methods of extending approved practices. The number of boys and girls completing livestock projects increased over 1925. The general use of local leaders, the acceptance of assistance from commercial agencies, and the development of projects in cooperation with other subject-matter specialists, have all served to strengthen the work and bring better results.

The year's results disclose a large increase in efforts to attract attention to and help solve the problems of work stock, although comparatively few organized projects were carried by the States. Demonstrations in big-team hitches were used widely as an entering wedge to solving the problems of horse husbandry. More prominence was given to meats, approximately half of the States reporting some phase of the work, including slaughtering, cutting, and curing of products for home consumption and the selection and purchase of meats by the consumer. The consumer's preference for lightweight cuts of quality beef had a marked influence on beef-cattle production in the range States as well as in the larger finishing areas of the Corn Belt. The tuberculin testing of animals and the immunization of swine against hog cholera, carried on in cooperation with Federal and State disease-control agencies, continued to be popular.

Important results in farm-sheep activities were obtained through teach-

ing the docking and castration of market lambs, the use of purebred rams, the control of stomach worms, and the better feeding of both ewes and lambs.

Swine sanitation, based on research carried on by the Bureau of Animal Industry on the control of intestinal parasites of hogs, occupied a prominent place in activities designed to improve the efficiency of hog production. Ton-litter work reached a new high mark in 1926 of 808 official ton litters as compared with 767 for 1925, the previous record.

The poultry industry enjoyed a very large and rapid growth. Favorable prices obtained for poultry and poultry products, and scientific discoveries, particularly in hatching and in nutrition, were largely responsible for this expansion. Culling of farm flocks still maintained the lead as the poultry practice most widely adopted. Feeding, breeding, poultry management, and disease control were other phases of extension activities designed to obtain improvement in poultry production.

DAIRYING

Leading phases of dairy extension were cow-testing associations, dairy calf and heifer clubs, better-sire campaigns, cooperative feeding schools, and short courses. In 8 of the 11 Western States the results of cow-testing associations ranked above any other activity. In 9 of the 12 Southern States the number of such associations increased 6.3 per cent. The state-wide better-sires campaign in Virginia resulted in 113 purebred dairy bulls being placed during the year; 350 were placed in North Carolina and 223 grade bulls were eliminated; and 155 were placed in Louisiana. The number of associations increased 10.8 per cent in 8 of the 12 Eastern States, and considerable increase was noted in the Central States, where Wisconsin led with 159 cow-testing associations organized during the year. Altogether, 932 cow-testing associations with 24,015 members were organized or reorganized in the United States during the year.

Some improvement in dairy practices was reported for 418,345 farms in 2,293 counties. Assistance in obtaining purebred sires of high quality was given to 11,766 farmers and in obtaining high-grade or purebred dams, to 16,192 farmers. Culling of dairy herds was practiced on 11,371 farms; 377,178 cows were tested for production on 20,505 farms; sanitary practices in milk production were adopted by 59,459 farmers; and the feeding of more satisfactory rations was reported for 46,578 farms. Extension agents also assisted in influencing 277,327 farmers to have their dairy animals tested for tuberculosis.

Work in dairy feeding was done principally by lectures and through providing a feeding-ration service. The home growing of feeds, improvement of pastures, building of silos, and improvement of dairy buildings were emphasized. In the Southern States feed supplies were abundant which tended to increase dairy herds.

Other features of dairy extension carried on were dairy-farm cost accounting, disease and pest control, and better care of milk. On the whole, dairy extension made a steady and stable growth.

RURAL ENGINEERING

The control of soil erosion was the outstanding rural engineering activity during the year. Through terraces and soil-saving dams, established with the help and advice of extension agents, 1,016,900 acres of farm land were restored to their full productive capacity. Such dams and terraces were constructed on 33,547 farms at a cost of from $5 to $10 an acre. Many farmers reported that increased crop yields the first year more than repaid them for the cost of the improvement.

Land clearing continued to be popular, and more than 261,000 acres on 44,961 farms were cleared of stumps and stones. Much of the work was done with pyrotol, the surplus war explosive, of which more than 11,200,000 pounds were distributed by the Bureau of Public Roads in cooperation with the State extension services.

The dry growing season of 1926 resulted in a reduction in the installation of drainage systems and an increase in the establishment of irrigation systems. Extension agents helped 4,456 farmers to install drainage systems and 4,278 farmers to install irrigation systems.

Extension activities to improve farm homes through the introduction of modern heating and lighting system, water systems, and sewage-disposal systems, contributed greatly to the saving of time and energy of the farm woman. Agents reported that their efforts resulted in the construction of 2,488 well-planned dwellings and the remodeling of 2,876 old dwellings according to plans furnished by extension rural engineers and the installation of

3,458 sewage-disposal plants, 2,775 water systems, 438 heating systems, and 2,131 lighting systems according to recommendations.

The planning of improvements for farm buildings other than dwellings was also an extension activity that contributed materially to improved housing conditions for animals, crops, and equipment. Extension agents reported that 27,271 farm buildings other than dwellings were constructed or remodeled according to plans furnished.

Numerous meetings were held to demonstrate the proper adjustment and use of plows, planters, cultivators, harvesters, tractors, gas engines, and other farm machinery, and to illustrate the use of lime crushers, seed cleaners, and similar equipment. Altogether 120,200 farmers adopted improved rural-engineering practices as a result of extension teaching.

FARM MANAGEMENT

An analysis of State programs and results for the year indicates that continued progress was made in teaching the keeping, summarization, and analysis of farm accounts; the dissemination of timely economic information; and the development of sound extension programs. Reports show that State programs were more stable and the field of work more clearly outlined. In developing State programs the following considerations received emphasis: (1) To reach the largest number of farmers possible; (2) to touch all the broad State problems of farm management; (3) to build for the future as well as for immediate results; (4) to distribute work over the year as evenly as possible; and (5) to make greater use of sound economic facts.

In aiding farmers to know more about the reasons for profit or loss in their farming operations extension agents organized farm-accounting work in 40 counties during the year, bringing the total number of counties in which this work is conducted up to 340. Farmers obtained 48,011 farm-account books during the year, of which it is estimated nearly 50 per cent were completed. The number of books summarized as a basis for guiding farmers in selecting and carrying on their farm enterprises increased from 4,965 in 1922 to 10,480 in 1926.

The value of improving methods of extension teaching to give a wider projection of improved practices is indicated by the reports, which show that more meetings were conducted, with increased attendance, more exhibits were displayed, more news articles were distributed, more local leaders were trained, and more records were obtained and summarized than in the previous year.

Five additional States conducted agricultural outlook meetings for the purpose of particularizing for State dissemination economic data regarding the probable production and demand for leading farm products supplied by the Bureau of Agricultural Economics. Three additional States began publishing the monthly agricultural economic situation, and one additional State introduced the teaching of farm accounting in the rural schools.

Changes in cropping and livestock systems, based on information obtained from extension agents, were made by 23,596 farmers, 10,554 farmers were advised regarding farm leases, and cost-of-production records were kept on 16,679 farms. A decreased interest of farmers in joining farm-loan or other credit associations is indicated by the reports of extension agents, probably because farmers were less concerned with methods of borrowing money than with methods of increasing their income through the improvement of their farm practices. It is also an indication that agricultural conditions, although not satisfactory, have improved during the last three or four years. In all, 56,232 farmers received benefit from farm-management extension.

MARKETING

Extension agents assisted farmers in the solution of their marketing problems. They gave consideration to the methods of disposing of farm products most advantageously and counseled with them on the type of cooperative marketing organization to form, the factors which limit the success of such associations, and the marketing of crops in accordance with accepted grades. Point-of-origin and terminal inspection of products increased in favor.

Extension activities in marketing carried on by 1,455 extension agents influenced 424,025 farmers to improve their marketing practices. Assistance in placing marketing on an organized basis was given 926 new cooperative associations, and 2,180 associations previously organized were assisted in solving management problems. The volume of business reported by these cooperative associations during the

year was valued at $232,340,696, with an estimated profit or saving of $16,477,578.

FOODS

The selection, preparation, and serving of wholesome food and the canning, drying, and curing of foods were given increasing prominence in the activities of home demonstration agents and home-economics specialists. Fruits, vegetables, fish, meat, and special products, such as jellies, soup mixtures, relishes, and fruit juices were prepared and preserved. Food storage was also reported by a number of States. Food-preservation activities helped farm women to make possible improved nutrition on a year-round basis; it brought sorely needed income into the farm home; and was an effective means of teaching farm women and girls the importance of high standards of product, of container, and of marketing procedure. During the year 83,866 women and 64,601 girls canned, dried, or otherwise preserved fruits and vegetables under the guidance of extension workers; 27,808 women and 10,897 girls preserved meats and fish; and 21,305 women learned food-storage processes. Altogether more than 117,000 different homes adopted improved practices in preserving their foods.

Home dairying as a means of producing better cheese and butter and of taking more sanitary care of the milk supply and home poultry raising also contributed materially to better foods habits and greater economic efficiency. As a result of this work, 15,790 families took better care of their milk and 22,148 made more wholesome cheese and butter. County agents influenced 21,270 farm homemakers to cull their poultry flocks and 21,367 to feed better-balanced rations; 8,704 were assisted in obtaining purebred cockerels, and 15,258 used improved methods of controlling insect pests. A total of 23,931 families adopted better home dairying practices and 63,063 adopted better methods of raising poultry for home use and market.

The home production of foods by growing gardens and orchards was emphasized in 48 States as a means of providing a more adequate supply for home consumption during the nonproducing months and of increasing the sale of surplus fresh and canned products. In the growing of orchards and gardens extension agents assisted 12,640 women and 5,296 girls to grow fruit trees, 10,080 women and 3,490 girls to grow bush and small fruits, 5,991 women and 2,225 girls to grow grapes, 50,926 women and 33,285 girls to grow vegetables, and 17,398 women and 7,749 girls to grow winter gardens. A total of 119,500 homes adopted practices recommended by extension agents.

Growing centers of population, in many parts of the South especially, stimulated the development of home demonstration club markets through which farm women and girls successfully disposed of their surplus fresh and canned products. The standardization of such products was an important part of the program of many home demonstration agents.

NUTRITION

Nutrition work continued along essentially the same lines as in the previous year, but in greater volume and with more effective methods, due in part to the foundation laid in past years and in part to the growing interest of the public in positive health habits.

The selection and preparation of proper foods to improve the food habits of their families were popular among farm women. The teaching of these phases of nutrition was usually based on the food-selection score card and included a discussion of positive health and a checking of food habits and physical condition, a simple study of food values, and the planning of adequate, simple, and appetizing meals, together with more or less food preparation. Numerous individuals were helped to overcome conditions of underweight, overweight, and constipation arising from faulty food habits by appropriate modifications of the food-selection score card.

As a result of these and other phases of the project, 57,907 women, 19,563 girls, and 893 boys were reported to have had balanced family meals for the first time according to improved methods. Increases in the use of milk, vegetables, whole-grain cereals, and water were the most noticeable individual results.

Attention was also called to the importance of including the right foods in the school lunch, both the lunch carried from home and that prepared at school. The proper preparation of the school lunch was emphasized with home makers and 4–H club members and other school children, with the result that 32,187 women, 30,749 girls,

and 2,826 boys reported preparing better school lunches, and 2,520 schools were induced and assisted by home demonstration agents and trained local leaders to serve a hot dish or a supervised lunch for the first time, in addition to the many schools continuing this practice.

A few States did intensive work with parents of school and preschool children on standard of growth and nutrition, food needs, meal planning, and habit training. Three States maintained full-time child-training specialists who emphasized the importance of food-habit training and explained the basic principles of child behavior from which problems in this and other types of habit training arise. Two other States maintained or directed part-time specialists in child training, which promises to be a growing field of usefulness. Better feeding practices for children were adopted in 37,182 homes as a result of this work.

Home demonstration agents and nutrition specialists again actively cooperated with schools and parent-teacher associations in planning, guiding, and directing various forms of health education, the food-selection score card being generally used as a guide to good food habits for school children.

In some localities the live-at-home program was necessarily supplemented by attention to the community food supply, resulting in joint action by extension agents, consumers, and merchants to obtain whole-grain products, or a safe and abundant milk supply, or to bring or ship in fresh vegetables, fruits, and poultry products, sometimes from great distances. Numerous local and country-wide surveys of food habits, food production, and food consumption were made in 1926. Educational milk-for-health campaigns were undertaken where per capita consumption was low and the milk supply was adequate and safe. In a few States where both supply and consumption were low it was attempted through milk-education weeks to stimulate both supply and demand.

With the slogan, "Make yourself your own best exhibit," widespread progress was made toward making 4-H club members physically fit by arousing interest in good food and health habits and showing the correlation of successful practices in livestock care and feeding with the food-selection score card. In a majority of States, all food-club members and many other club girls checked their food habits by the food-selection score card. A growing number of club boys did the same. The points of a well-built and well functioning body, good food and health habits, and training in posture were emphasized at many State club camps and short courses by the use of appropriate slides and motion pictures.

CLOTHING

Clothing continued to be one of the most popular phases of home-economics activities. Clothing construction, renovation, and repair were generally popular projects, and the proper selection of clothing for each member of the family with regard to color, design, and material suitable to the individual for each occasion was taught in many places. New Hampshire reported a style show, not on the temporary prevailing mode but on the basic principles of line, design, and color learned by women in the clothing-project work.

In many States extension agents demonstrated the care of the body, posture, selection of correct corsets and comfortable shoes, and other phases showing the relation of clothing to health. Much interest in millinery selection and repair was shown. This work has succeeded in developing better taste among farm women in the construction and trimming of hats to fit the face and the costume, as well as in reducing the clothing expense of the farm family.

The selection and making of infant's and children's clothing, efficient use of the sewing machine, the importance of wearing clothing appropriate to the occasion, the making and use of dress forms, and the keeping of clothing budgets were other features of clothing activities receiving the attention of extension agents during the year.

The scope and volume of results achieved in the major phases of clothing work are indicated by the following figures: 165,070 women and 118,576 girls selected and constructed garments according to the advice of extension agents; remodeling and renovating was done by 60,329 women and 36,762 girls; 61,336 women and 13,104 girls trimmed their own hats; 12,934 women and 3,270 girls planned infant wardrobes; 39,061 women and 16,306 girls planned children's wardrobes; 63,771 women and 29,454 girls planned adult wardrobes; and 21,205 dress forms, 560,837 dresses and coats, 714,744 undergarments, and 118,828 hats were reported as made by farm women with the advice and help of extension agents.

HOME MANAGEMENT

To improve the mental and physical condition of the housewife, to give her more leisure for social activities, recreation, and study, and to place the home on a sound economic basis, extension agents influenced many women to rearrange their farm kitchens, to install modern home equipment, and to budget the needs of the farm home and keep accounts of their expenditures.

As a result of this work, farm home makers kept records of the time consumed in daily household tasks and the amount of labor performed. Plans were made to reduce the hours of labor and institute rest periods for each day. Written schedules of work were prepared and meals were planned a week in advance. They analyzed their own problems and rearranged the entire sequence of their daily duties, thus performing the work satisfactorily in less time and releasing the women from much aimless and useless expenditure of energy.

During the year all States gave attention to a study of household equipment, its selection, utilization, and arrangement for efficient use. The improvement of kitchens, living rooms, dining rooms, and bedrooms was reported as following demonstrations in a number of States. The installation of septic tanks, electric lights, running water, sewage-disposal systems, modern laundry equipment, pressure cookers, fireless cookers, better floors, and other improved equipment and labor-saving devices proved to be popular means of making management of the home easier and more efficient.

With the advice and help of extension agents, 41,029 women installed labor-saving equipment in their homes; 13,742 women and 4,475 girls planned their housework better; 21,575 women rearranged their kitchens; 8,893 women and 6,158 girls learned better laundry practices; and 7,704 women and 3,380 girls kept budgets and accounts. A total of 74,038 homes were influenced to adopt better practices of managing the home.

HOUSE FURNISHING AND BEAUTIFICATION

Principles of artistic selection and arrangement of furniture, draperies, and household accessories, the correct use of color and design in making farm homes attractive, inside and out, refinishing and upholstering of old furniture, and the proper hanging of well-selected pictures were taught during the year by extension agents in an effort to increase the general pleasure and comfort of the farm family. Instruction was given to farm women and girls in the making of artistic baskets, rugs, lamp shades, picture frames, book ends, footstools, shelves, magazine holders, waste baskets, and desk sets. Orderliness, beauty, and an atmosphere of hospitality were brought into thousands of farm homes through the influence of extension workers.

As a result of this work, 63,675 women and 26,306 girls selected and arranged suitable furnishings, 34,029 women and 14,141 girls repaired and remodeled furnishings, and 38,401 women and 10,194 girls refinished floors, woodwork, and walls. Improved practices were adopted for the first time in 106,789 homes during the year.

Increasingly large numbers of farm people were also interested in making their farm homes attractive on the outside as well as inside. Through county-wide tours and contests, demonstrations, exhibits, news, and other agencies, farmers were apprised of the pleasure and value of having attractive homes, with the result that thousands of homes were painted, farmyards were cleaned, fences and trellises were repaired, unsightly spots were screened from view, flower gardens were planted, lawns were well cared for, and shrubs were placed to enhance the beauty of the home and grounds. In addition to the beautification of home grounds attention was given to improving the appearance of public parks, highways, boulevards, school grounds, and cemeteries. The growing of flowers by women and girls for marketing, as well as for home decoration, has proved to be a profitable enterprise.

During the year extension effort caused 8,367 home grounds and 1,328 school and community grounds to be planted and 8,823 houses to be painted or whitewashed. Altogether, 49,524 homes adopted some phase of home beautification.

HOME HEALTH AND SANITATION

To establish positive health for the individual and to promote ideal community sanitary conditions were the objectives of many extension workers during the year. Extension agents inspired many farm people to obtain and retain health through eating the right foods, sitting and standing correctly, exercise, selection of comfortable shoes, corsets, and clothes, sufficient sleep, personal hygiene, and the care of eyes, teeth, and ears. Of distinct

help to rural people not living near doctors or nurses was the service given by agents in teaching simple, curative measures for the sick, proper home care of the patient, and first-aid treatment during emergencies. Local leaders brought helpful information to farm people in communities far removed from professional, medical, and nursing aid.

Traveling dental clinics arranged cooperatively by dentists and educational and extension officials were held in some States. An additional number of States reported preschool age clinics as a means of aiding mothers in determining health standards for their children. Health and food-habits score cards continued to be used extensively in teaching positive health standards.

Much good was also accomplished by extension agents through demonstrating home sanitation, including screening against flies, installing facilities to provide pure drinking water, proper ventilation, sewage disposal, and adequate provision for bathing. A number of States carried on home and community clean-up campaigns, which resulted, among other things, in the eradication of refuse from vacant lots and in the improvement of public schools.

These activities of the agents resulted in the adoption of improved health and sanitary practices in 65,421 homes, of which 63,159 adopted some recommended health practice, 8,129 installed sanitary closets or outhouses, 7,614 were screened to protect against flies and mosquitoes, and 16,712 followed other methods of controlling flies and other insects.

REGIONAL REPORTS

Outstanding developments in extension activity are discussed by regions—eastern, central, southern, and western—into which the administrative work of the office is divided. During the year Miss Florence E. Ward continued as regional agent representing the office in its cooperative relations with the Eastern States, G. E. Farrell in the Central States, O. B. Martin in the Southern States, and W. A. Lloyd in the Western States.

EASTERN STATES

The Eastern States include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia.

The growing of leguminous roughage to reduce the cost of feeding dairy cattle was emphasized by extension workers in this region. The work centered mainly in teaching farmers to grow alfalfa. This need was well expressed by the director of extension in New Hampshire when he said: "For every dollar's worth of dairy products sold the average New Hampshire farmer spends 90 cents for feed, whereas in Wisconsin the average farmer spends only 16 cents for feed. This is the basic reason for the intensive campaigns which the extension service has been waging for more alfalfa." Dairy production was further aided in many States by attacking the problem of getting higher-producing cows by emphasizing the need for better bulls. To improve the dairy industry intensive campaigns were conducted to eradicate tubercular dairy cattle.

Poultry raising was recognized as one of the important agricultural industries of this section. The work of many extension agents in improving poultry production centered about disease and parasite control, although the proper feeding and management of farm and commercial flocks continued to be an important part of every poultry program.

During the year extension specialists and agents cooperated with marketing agencies in teaching the production of better fruits and higher quality eggs and other agricultural products and in interesting growers in the better grading and packing of these products for the local markets. Renewed interest was taken in spraying and fruit-growing practices which aim to produce a higher quality of fruit.

The number of farms influenced by extension work in improving potato-growing practices in the eastern section ranks next to poultry and is greater than the number practicing fruit improvement. Major emphasis is placed on the prevention of diseases and the use of the highest quality of improved seed. As a result of the campaign in Maine 2,413 growers reported having planted 77,459 acres with improved seed potatoes. This represents about 65 per cent of the total acreage of the State.

Forestry extension work was carried on in 10 Eastern States. Where a supply of seedlings from forest nurseries maintained by the State was available, the planting of trees on land not in crop received increasing attention. The next most important project

was the teaching of the care and management of existing farm wood lots. Berks County, Pa., carried on a woodlot management campaign marked by unique features, and 125 farmers followed the recommendations for the care of their wood lots. Demonstrations were conducted at which the various methods of estimating timber were explained, including the use of a cruising stick. As a result of 75 demonstrations of this kind conducted in 11 counties and attended by 892 persons, 262 persons purchased cruising sticks for use in their home wood lots.

In the field of home economics the extension work in clothing selection and construction continued to be popular. Nutrition work was developed to meet more nearly the needs of the people, and a consequent growth of interest in the work resulted. Massachusetts reported that the enrollment in the food-selection groups and the results obtained in 1926 doubled the figures for 1925 and that three times as many people were taught by leaders. The teaching of home management was centered about problems of home making fundamental to the health and welfare of rural families.

Specialists and home demonstration agents gave greater attention to projects which make the operations of rural housekeeping easier. The installation of running water in the home and the establishment of sanitary sewage systems were encouraged. Pennsylvania reported that through the use of demonstrations 445 concrete septic tanks were built in rural homes last year. Connecticut has adopted as a major project a "water-in-the-kitchen-sink" campaign. This project is designed to teach farmers how to install safe and cheap water systems where water is still carried from pumps or springs to the home.

Improvement of extension teaching methods and interest in extension work have increased during the past year. At the annual conference of extension workers of the Eastern States, February 23 to 25, 1927, a prominent member of the department of education of a large eastern university discussed problems of teaching methods at the joint sessions. In New Jersey six members of the extension staff, including the director, have taken leave in order to seek professional improvement at various colleges.

This interest in better methods is being expressed in better plans of work developed by extension specialists and in effectiveness of methods. Particular effort was made to plan and execute well-organized extension campaigns in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, and New York.

New York State reported new seeding of 7,104 acres of alfalfa as a result of campaigns conducted in eight counties. New Hampshire as a result of campaigns doubled its acreage of alfalfa from 1,500 to 3,000 acres, approximately, and has plans for doubling the present acreage during 1927. New Hampshire also reported that about 400 persons cooperated in a better-fruit campaign. Connecticut reported that in eight counties last year 340 purebred bulls were placed as a result of their purebred-bull campaign, and Maine, which has also developed a well-planned better-bull campaign, reported 273 purebred dairy bulls placed last year. As a result of the "grow-healthy-chicks" campaign in Connecticut a thousand poultrymen growing nearly a million chicks promised to follow the methods outlined for controlling disease and parasites. The records obtained on over 500,000 of these chicks show a reduction in deaths of 11.6 per cent, as compared with 1925. New York and Pennsylvania show correspondingly good results of extension teaching in a well-planned forestry campaign.

During the year 283 county agricultural agents, 171 home-demonstration agents, 88 county club agents, and 244 extension specialists were employed. Boys' and girls' 4–H club work was on an exceptionally satisfactory basis, Connecticut, New Hampshire, and Massachusetts employing 4–H club agents in practically every county. The funds provided for extension work in this region increased from $3,934,997 to $4,090,472. In Connecticut the State legislature has appropriated funds for the employment of 4–H club agents in every county of the State. Vermont enacted legislation for increased appropriations from county funds in support of county extension work.

CENTRAL STATES

The Central States include Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

Tuberculosis eradication, poultry culling, swine sanitation, legume production, land clearing, nutrition, clothing, and home management were leading lines of extension activity in the Central States. Nearly 200,000

farmers were directly influenced by county agricultural agents during the year to have their dairy and beef animals tested for tuberculosis, and 2,417,000 head of poultry were culled, resulting in more than a half million head being disposed of.

Last year 1,213 farmers in 75 Illinois counties demonstrated the McLean County system of swine sanitation on their farms and thereby increased their combined net incomes by an estimated total of $254,730. The reports indicate that on many farms where nearly half the pigs died in previous years from worms and necrotic infection, the same farmers raised, through hog-lot sanitation, 94 per cent of the pigs saved at birth. In 1926 there was an average of only 1 runt among every 71 sanitation pigs as compared with 1 runt to 11 pigs raised the old way on the 160 farms which reported using both systems for comparison. With sanitation the litters raised averaged 1.5 pigs more than before these farms used sanitation; the pigs averaged 24 pounds heavier when 4 months old, and they were ready for market at usual weights when 6 weeks younger than usual.

Ohio reported 1,287 poultry-demonstration farms cooperating in 81 counties. A survey of the farms showed that for each farm five people improved their practices each year. The average eggs per hen for the year on the demonstration farms completing their records was 140. Eighteen Nebraska poultry-demonstration farms which have been cooperating for five years reported an average production of 162 eggs per hen and a return of $4.12 per hen over feed cost.

According to assessors' reports in Kansas, sweet clover was increased from 29,967 acres in 1922 to 190,014 in 1926, largely through the efforts of the county agents.

The total amount of pyrotol for land clearing distributed primarily through county agents in the Central States during 1926 was 5,596,350 pounds, which at a conservative estimate of 10 cents per pound represents a saving to farmers of nearly $600,000. The States receiving the greatest amount of this explosive were Michigan, Minnesota, and Wisconsin.

The total value of products sold by cooperative marketing associations organized during 1926 or previously through county-agent work was $123,801,116, and the total savings or increased net returns to farmers through such associations was $4,074,203.

Nutrition, clothing, and home management continued as outstanding projects with farm women. Health projects were carried on in all States, and four States had extension health specialists. Project work in food preparation was completed by 36,385 women and that in food preservation by 10,776; more than 50,000 homes adopted improved practices relative to nutrition; 751 schools were induced to serve one hot dish for school lunches for the first time; and 13,000 homes used improved practices in child feeding. Better health of adults and children, reduction of physical ailments—such as constipation, overweight and underweight, headaches, indigestion, and the like—are among the results of the nutrition work reported by home demonstration agents and nutrition specialists.

More than 91,000 women and girls completed the clothing project work and made or remodeled more than 200,000 garments, dress forms, and hats under the supervision of the home demonstration agents or specialists; 24,450 homes adopted improved practices relative to home management; and 14,564 homes were influenced to provide labor-saving appliances. Many States emphasized efficient equipment and its arrangement. Testing circles continued as effective means of teaching the desirability and comparative merits of different types of household equipment.

The number of women who adopted improved practices in selection and arrangement of furnishings was 30,962; in repairing and remodeling furnishings, 9,236; in wall, woodwork, and floor treatment, 16,408. More than 18,000 women and girls completed their project work in health and sanitation.

Achievement days were one of the most popular means devised for combining recreation with some phase of home demonstration work. They were held in every State, practically all counties participating therein. During 1926, 51 farm women's camps were held in the Central States.

In 11 States county-wide administrative committees of farm women functioned in promoting and making effective home demonstration work. The value of having county-wide administrative committees of farm women to counsel with the home demonstration agents on all matters of county-wide policy, programs, and procedure was mentioned by all States.

Of the total number of farm boys and girls enrolled in 4–H club work, 138,168, or 72 per cent, completed all

requirements of their project. In agricultural and home-making projects 2,089 judging teams were trained, most of which participated in competitive judging contests. A total of 5,026 demonstration teams were chosen and trained to present public demonstrations. During the year 525 4–H club encampments were held with a total attendance of 38,715 members and leaders.

An increase was noted during the year in the number of local 4–H clubs which prepared written local and county programs of work. One specific phase of 4–H club work which received the universal attention of State leaders in the Central States was local-leader training. Recognizing the value of obtaining news notes on extension work, many States reported that attention was being given to training reporters among the 4–H club members. The extension news specialist in Ohio held from two to four meetings with each club in 25 counties and gave a short course in the preparation of material for the local newspapers.

On June 30, 1927, there were 1,547 extension workers in the 13 Central States, including 15 extension directors and assistant directors; 819 county agricultural agents; 7 assistant county agents; and 48 supervisors of county-agent work. There were also 124 county home demonstration agents and 25 supervisors of home demonstration work; 48 county 4–H club agents, 57 club supervisors, and 404 extension specialists.

The total amount allotted for extension work during the fiscal year ended June 30, 1927, in the Central States was $6,859,399. The financial trend was toward increased local support of the work from county funds and a corresponding release of funds formerly contributed from farmers' organizations toward the salary and expenses of county extension agents. The amount raised by county appropriations was approximately $150,000 more than the sum raised during the previous year.

SOUTHERN STATES

The Southern States include Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

The year was conspicuous in the South for unfortunate situations which arose and made it necessary for extension agents to readjust their work to meet constantly changing economic conditions. Despite the efforts of extension workers to put the South on a safe-farming basis by keeping feed and food crops properly balanced with cotton and tobacco, and notwithstanding the depredations of the cotton-boll weevil, flea hoppers, and other pests, the South produced in 1926 the largest cotton crop in history. This resulted in an immediate slump in cotton prices to a level lower than any since 1921. Because of the increased cost of producing cotton under boll-weevil conditions, the crop moved to market at prices less than cost of production. Extension agents met the unfortunate situation by placing increased emphasis on the home production by the farmer of sufficient food for his family and feed for his livestock. It was pointed out that the safe-farming program, which also includes the maintenance and building up of soil fertility and the growing of crops and livestock suitable for local conditions, gives an assurance for the future which can not be obtained when all or practically all of the acreage is devoted to cotton. Agents also demonstrated that the intelligent application of the best methods in growing cotton will result in the same volume of production on less acreage and at a lower cost of production, thus allowing a greater margin of profit and more land for the practical diversification of crops.

The unprecedented flood which swept down the Mississippi Valley and overflowed thousands of acres of improved farm lands in Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee was an appalling disaster which called for a great deal of sympathy, tact, and unselfish effort on the part of extension agents. The important problems met by the agents were to maintain the morale of farm families who were forced to evacuate their farms, to aid in obtaining seed, equipment, and supplies in order that crops could be planted promptly after the water subsided, and to give advice about crops for replanting. The extension forces cooperated closely with the Red Cross in determining and meeting the needs of farmers and in the restoration of the farming life of the flooded districts.

The hurricane which laid bare the farming land of several counties in Florida in September, 1926, was equally disastrous over a smaller area, and the problems of relief and rehabilitation were met equally well by the extension agents. In meeting these emergencies and in carrying on their

regular activities, extension agents throughout the South—men and women, white and negro—added proof to the fact previously established that they are necessary economic factors in the lives of farming people.

Significant and successful work was done in developing county plans of work. This was strictly a cooperative activity, participated in by the two or more county agents in each county and by leading business men and women. Using census figures and records of freight and express receipts and shipments, the greatest needs of the counties were ascertained. Then a representative advisory council was formed to back the agents in carrying out the plan. In nearly every case it was found that the county produced inadequate feed and food supplies. Thus the foundation for demonstrations on the farms and for intelligent activities by farmers and business men in manufacturing and marketing was laid.

Demonstrations during the year proved, as they did in previous years, that there can be no permanent success in agriculture without soil building. Work with legumes made splendid progress, in spite of the preference for cash crops. Several States reported that their acreage of soy beans doubled in one year and that the increase for several years has been notable. Likewise, alfalfa, vetch, sweet clover, bur clover, and other winter legumes increased in acreage. In all sections where terracing is needed great progress was made. This is a fundamental step in soil improvement. In Alabama it is estimated that terracing increased the value of the land $5 an acre and that legumes turned under increased the value $10 an acre. Alabama has made some of its crop demonstrations so widespread and clear with the incidental instruction on legumes, fertilizers, and cultivation, that farmers everywhere speak of the practice as the Auburn method.

The increase in poultry and dairy cows was a wholesome continuation of previous progress. The extension director of Georgia reported that the value of the poultry industry increased from almost nothing to $30,000,000 within a few years. Mississippi estimated that the dairy industry increased sixteenfold during the last five years. In that section of the South new creameries, condenseries, and cheese factories added to the importance of the dairy output. Home dairying had a similar increase.

The enrollment in boys' and girls' 4–H club work showed an increase. There seems to be a gradual growth, also, in the size of the enterprises undertaken by boys and girls. Some of their crop yields and livestock production went into large figures with good showings of profit. Many corn yields went above 100 bushels per acre, cotton more than 2 bales, ton litters above 2,000 pounds, poultry flocks above $500 profit, and other demonstrations in proportion. Such results increased the importance and enhanced the standing of club work.

Although the women and girls did excellent work in home improvement and beautification, they also did well with gardens, poultry, and dairy cows. They canned vegetables, fruits, and meats for home use and for market. They carried on new industries, utilizing the resources of the garden, the farm, the orchard, and the forest. The home demonstration agents worked in even better cooperation than formerly with the county agents and the advisory councils.

The most significant development in cooperative marketing was organization for the sale of many small commodities. Of course, the agents gave encouragement and advice to marketing associations handling such large commodities as cotton and tobacco, eggs, chickens, turkeys, lambs, hogs, hay, potatoes, truck, and other crops and products. They helped bring about standardization, shipping-point inspection, and good marketing in general.

Evidences of the progressive spirit of the people were shown in every State. Money expended for extension work increased from $6,139,600 in 1925 to $6,270,553 in 1926, and the number of workers from 2,048 to 2,104. Popular support of the extension movement has been the result of demonstrations of increasing magnitude, content, and value put on by farmers and members of their families under the inspiration and guidance of the agents. In a number of States demonstrations involving 5, 10, 50, and 100 acres were made. Impressive object lessons were given with large herds of cattle and hogs and large flocks of sheep, chickens, and turkeys. Crop demonstrations involved such operations as soil preparation, fertilization, cultivation, harvesting, and marketing. Livestock work included housing, sanitation, breeding, feeding, and all other operations necessary to the obtaining of good profits. In Tennessee the extension forces have been endeavoring to induce farmers to make demonstrations of their whole farms. This is the proper basis for real leadership.

WESTERN STATES

The Western States include Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

The principal extension activities emphasized in this region were concerned with range livestock, dairying, farm crops, human nutrition, home management, and farm management. These activities were carried on in conformity with the recommendations of the conference of extension directors held at Pullman, Wash., in November, 1925, when the regional extension program for the Western States was expanded to include home management and farm management.

The process of developing a long-time constructive extension program based on economic facts carefully organized and considered has helped extension workers in the Western States to focus their efforts on broader regional objectives; it has brought extension and research personnel of the State and Federal Governments into better working relationship; it has resulted in a closer coordination of projects within the States and among the States; it has revealed the need for more information on subjects upon which at the present time there is a lack of pertinent data, and in other ways has proved its merit.

The development of State and county programs also made considerable progress. During the year, four additional States perfected organizations for the assembling of facts for use in the formulation of permanent county, State, and regional programs. Such fact organization was begun about 1923, and by 1927 8 of the 11 Western States had started some phase of the work. The facts are assembled both on a geographical (State and county) and an enterprise basis.

Careful study was made by the extension directors of the problem of completing the extension organization necessary for present requirements. A definite plan was adopted by each State providing for gradual increases of personnel and funds and contemplating the completion of the extension system in from 12 to 15 years.

Extension workers continued to make progress in practically all lines of activity during the year. The introduction of purebred animals as a means of herd improvement, cooperation with disease-control agencies in the tuberculin testing of dairy animals, immunization of swine against hog cholera, and influencing the spread of recommended practices for the control of other livestock diseases all received prominent attention by the county agricultural agents. As important phases of feed-crop production, work was carried on to develop the irrigated and dry-land pastures and in some places to rebuild and reseed the open range. A total of 45,581 instances in which improved livestock practices were adopted for the first time by western farmers in 1926 were reported by extension agents. This included 33,099 farmers who accepted better dairy practices and 16,665 farmers who accepted better poultry practices.

In spreading improved methods of crop production, extension agents emphasized particularly the development and wider use of improved varieties of seed, the standardization of a few principal varieties to insure sources of good seed in each community and to simplify the problem of marketing, the control of disease, especially the control of grain smut through the use of the copper-carbonate treatment, and the control of weeds and pests. As a result of extension activities in the varietal standardization of seed whole communities are growing one approved variety best adapted to their local conditions.

In the improvement of farm-home conditions in the Western States, extension agents centered their activities on teaching the farm family to know and practice right food habits; to provide efficiency, comfort, and attractiveness in the home; to design, make, and wear clothing for all occasions; and to promote community sanitary conditions necessary for good health.

Home demonstration work made satisfactory progress during the year. Five additional agents were appointed, and the number of counties reached by a local agent increased by eight. Eighty-seven per cent of the county agricultural agents in counties not covered by county or district home demonstration agents carried an increased amount of home demonstration projects. Much attention was given to the training of project leaders with beneficial results.

In boys' and girls' 4–H club work, 37,880 farm boys and girls were enrolled, of whom 26,275, or 69 per cent, completed all requirements of their projects. Ninety-eight per cent of the western county extension agents conducted club work.

The total funds available for extension activities during the fiscal year were $2,527,903.15, or practically the same as for the preceding year. There

were no important changes in administrative organization, and the personnel was remarkably stable, the average period of service for all classes tending to increase. The average period of service for the various classes by years is as follows: Men supervisors, 7.5; women supervisors, 6.4; men county agents, 5.7; specialists, 5.2; and women county agents, 4.3. Salaries have also shown an increase. Many counties have shown a tendency to reestablish extension work where it was discontinued after the war. The total number of persons employed increased from 528 in 1925–26 to 538 in 1926–27.

DEMONSTRATIONS ON RECLAMATION PROJECTS

Demonstration work on Federal reclamation projects for the year, as in the past, centered largely around the building up of the livestock industries. The industries receiving attention were dairying, poultry, swine, beef cattle, and sheep. Improved feeding practices, purebred sires, culling of inferior individuals from flocks and herds, sanitation, and organized marketing of farm products were the principal lines of work.

SCOPE OF THE WORK

In carrying on the work 7,577 farm visits were made, 13,071 farmers called at the offices of the demonstration agents, and 6,207 called over the telephone for information. Some 13,000 letters were written by the field men and 250 articles prepared for the local press. Method and result demonstration meetings to the number of 918, with an attendance of 7,592, were held, and other meetings numbered 596, with an attendance of 29,531. The number of animals involved in the demonstrations were: Dairy cattle, 716; beef cattle, 280; swine, 119; sheep, 8,108; and poultry, 12,860. Over 270 farmers were assisted in obtaining purebred sires. Boys' and girls' club work has always been an important phase of the demonstrations. During the year 497 were enrolled in it and 389 completed the work outlined.

Organized demonstration work is under way on 11 projects, namely, the Belle Fourche in South Dakota, the Flathead and Huntley in Montana, the Minidoka in Idaho, the Klamath and Umatilla in Oregon, the Newlands in Nevada, the Strawberry in Utah, the Uncompahgre in Colorado, the Shoshone in Wyoming, and the North Platte in Nebraska. Several of the other projects desired assistance, but lack of funds prevented rendering it.

ECONOMIC CONFERENCES

A new phase of work to which considerable time was given during the last year has been the economic conferences. The first conference of this kind in the West was held in Oregon in 1922 as a basis for formulating State and county agricultural programs. Since then several other Western States have adopted the plan. The object of the conference has been to bring together all the available facts on the agriculture of the section under consideration that would be helpful in outlining a definite agricultural program. This type of work has been so effective in interesting the local people in their own problems that the office of demonstrations on reclamation projects asked the State extension directors to extend it to the Federal irrigation projects. Such conferences have been held so far on the Umatilla and Klamath projects in Oregon, the Huntley, Flathead, and Lower Yellowstone in Montana, the Rio Grande in New Mexico, and the Newlands in Nevada.

The conferences, while initiated and directed by the State extension services, have not been purely extension affairs. The college and experiment station staffs, the Reclamation Service, the railroads, the local organizations, and representatives of the United States Department of Agriculture have all taken active part in them. The work thus far has been a fine demonstration of cooperation, in which all interests have joined together to do a constructive piece of work for the good of the project.

While the actual holding of the conference takes from two to three days only, the preparation for it requires several weeks of careful work on the part of those who participate in it. The essential features in organizing and conducting these conferences are: To create an interest in them on the part of the college and local people and gain their support, to determine the kind of information to be gathered, the source and extent of it, the detail in which it is to be gathered, and those who are to be responsible for assembling and compiling it.

Having decided on the scope of work to be done, the next step is to perfect a conference organization, which consists of a general conference committee with a number of special commodity committees. The general committee is usually made up of the chairman of the special commodity committees, with the local extension representative on the project acting as

its secretary. The number and size of the various committees depends on the diversity of the agriculture and the amount of work to be done.

On the Umatilla, the first irrigation project to hold an economic conference, 8 committees handled the work, while on some of the larger projects as many as 15 committees were appointed. The number serving on a committee varied from 5 to 20. Care was taken to have all communities and organizations interested in the commodity on which data were being gathered represented on the committee handling the commodity. The chairman and members of the various committees, with the exception of the secretary, were selected by the local representatives of the extension service, in cooperation with the heads of the local farm organizations. The committee chairmen were not only successful producers of the commodities handled by their committees, but also leaders in their respective communities. The secretary was a specialist from the college. On him fell the responsibility of seeing that the data collected were properly compiled and interpreted, and that a committee report was prepared and submitted to the general conference for approval.

Before the local committees were put to work the specialists at the college who were to act as secretaries for the various committees prepared, in conference with others, questionnaires to be used as a guide by members of their committees in gathering the local data. When the questionnaires were distributed to the members of the committees definite instructions were given as to how they should be filled in and the kind of farmers from which information was to be obtained. When the committee had completed the questionnaires they were turned back to the extension service for compilation.

The data collected were relative to crop acreages, yields, prices received, cost of production, freight rates, shipments in and out, present markets, new markets, land values, land utilizations, credit situation, cropping systems, cultural methods, introduction of new crops, plant and livestock diseases, number and kind of livestock on farms, feeding practices, and the establishment of new industries. Similar data from a State and national standpoint, in so far as it affects the local situation, were prepared by the college and United States Department of Agriculture and made available to the local committees.

During the time the economic data were being collected, the plans were given wide publicity by the local press and committees. A special effort was made to have it understood that while committees were designated, no one was excluded from any of the meetings, but all were welcome to attend any of the committee meetings in which they were interested and were especially urged to attend the general conference meetings.

Most of the economic conferences were two-day occasions. The first day and a half were devoted to the meetings of the various committees. In the committee meetings the data collected were carefully gone over and discussed by all present, after which a report was drafted of its findings and recommendations and submitted to the general conference for its approval. The last afternoon and the evening, where necessary, were used in a general session of the conference at which the committee reports were read and adopted. The adopted reports were then edited by the general conference committee and representatives of the extension service, and published as the conference report. Where funds were available, the extension service published the conference report in bulletin form for distribution among the farmers on the project. If funds were not available for publication, the report was mimeographed and sent out to a limited number. The data and recommendations embodied in the report were then used in formulating a definite agricultural program for the project.

In the conferences thus far conducted the interest has been unusually good. This method of bringing to the attention of a community a picture of its agricultural situation and how it might be improved is one of the best so far developed.

MOTION PICTURES

On November 30, 1926, Fred W. Perkins, who had been chief of the office of motion pictures since 1920, resigned to enter the commercial motion-picture field, and was succeeded by Raymond Evans. In April C. A. Lindstrom was transferred from the office of exhibits to the office of motion pictures as associate chief in charge of administration and distribution. At the same time Edward Kelly was made assistant chief in charge of production.

During the year 18 new motion pictures were completed and released, with a total negative footage of 18,927

feet. Of these new pictures 276 copies have been printed and put into circulation, making an aggregate of 383 reels. The total number of copies of films added to stock, including replacements of older films, was 386. At the close of the year the total number of subjects in circulation was 222, of which there were 1,792 copies, with a total of 2,746 reels.

Copies of Department of Agriculture films sold during the year to cooperating institutions, foreign governments, and other authorized purchasers total 280 prints. Of these 80 prints went to 10 foreign countries. Domestic purchasers included 15 State universities and colleges of agriculture, 4 State departments of agriculture, 2 boards of education, 2 State boards of health, 6 State forestry associations, 2 State departments of entomology, and 3 farmers' cooperative associations.

Circulation of films has shown a steady increase in volume. The actually reported attendance at showings of department films distributed from Washington totaled 4,300,864, as against 2,453,171 for 1926.

The real increase in number of persons viewing the films is not so great as would appear from this comparison, however, since during the last year reports have been obtained from nearly 90 per cent of borrowers, as against fewer than 75 per cent for 1925. These figures do not take into consideration circulation by outside agencies which have bought copies of Department of Agriculture films. Such agencies have in circulation fully as many of these films as has the department itself.

NEW FILMS COMPLETED

The 18 new films completed and released during the year are:

The Corn Borer and What to Do About It, 2 reels, Bureau of Entomology.
Corn and the Borer, 1 reel, Bureau of Entomology.
Mother Takes a Vacation, 2 reels, Extension Service.
The Club, College, Farm, and Home, 1 reel, Extension Service.
The Family Goes to College, 2 reels, Extension Service.
Southern Cattle, Yesterday and To-day, 1 reel, Bureau of Animal Industry.
Shed Lambing in the West, 1 reel, Bureau of Animal Industry.
Brooding Chickens, 1 reel, Bureau of Animal Industry.
Roads in Our National Parks, 1 reel, Bureau of Public Roads.
The Men Who Build the Roads, 1 reel, Bureau of Public Roads.
A Road Out of Rock, 1 reel, Bureau of Public Roads.
Rocky Mountain Park Roads, 1 reel, Bureau of Public Roads.
New Roads in Rainier, 1 reel, Bureau of Public Roads.
Yosemite's New Roads, 1 reel, Bureau of Public Roads.
Wheels of Progress, 2 reels, Bureau of Public Roads.
The Forest—and Water, 1 reel, Forest Service.
Cooperative Marketing in the United States, 2 reels, Bureau of Agricultural Economics.
A New Method of Harvesting Cotton—Sledding, one-half reel, Bureau of Agricultural Economics.

NEW FILMS IN PREPARATION

The following films have been assembled and titled ready for release early in the current year:

Old Jake Wakes Up, 1 reel, Bureau of Entomology.
Battling Airplane *v.* Kid Bug, Bureau of Entomology.
Saving Soil by Terracing, 1 reel, Bureau of Public Roads.
Forest Fire, 2 reels, Forest Service.

Films in preparation, most of which should be ready for release before the end of the current year, include the following:

Back of the Weather Forecast, Weather Bureau.
Animal Heredity, Bureau of Animal Industry.
The Barnyard Underworld, Bureau of Animal Industry.
This Little Pig Stayed Home, Bureau of Animal Industry.
Blood Will Tell, Bureau of Dairy Industry.
Quality Counts, Bureau of Dairy Industry.
Seed Inspection, Bureau of Plant Industry.
Soy Beans at Home—Manchuria, Bureau of Plant Industry.
Persimmon Harvest and Storage in China, Bureau of Plant Industry.
Wild Flower Preservation, Bureau of Plant Industry.
Apples or Cedars? Bureau of Plant Industry.
Burning Brush, Forest Service.
The Forest and Health, Forest Service.
Why Moths Leave Home, Bureau of Entomology.
The Gypsy Moth and the Brown-Tail Moth, Bureau of Entomology.
Million Dollar Pockets, Bureau of Biological Survey.
How to Get Rid of Rats, Bureau of Biological Survey.
The Travels of a Banded Duck, Bureau of Biological Survey.
Look Ahead, Bureau of Agricultural Economics.
The Hog Business, Bureau of Agricultural Economics and Bureau of Animal Industry.
Food Makes a Difference, Bureau of Home Economics.
Mrs. Happy-Go-Lucky's Day, Bureau of Home Economics.
Carry On, Extension Service.
Under the 4–H Flag, Extension Service.

EXHIBITS

The office of exhibits continued during 1927 under the supervision of Joseph W. Hiscox. The only important change in personnel during the year was the transfer on May 1 of

C. A. Lindstrom, in charge of exhibitions, to the office of motion pictures. He was succeeded by George H. Cook. At the end of the fiscal year the permanent personnel numbered 26 in Washington and 9 at the warehouse shops, Alexandria, Va., a net increase of 1 during the year. The department's participation in the Sesquicentennial International Exposition at Philadelphia and the Third World's Poultry Congress at Ottawa, Canada, under special congressional appropriations, necessitated the employment of an emergency force of 21 employees for varying periods, consisting of planners, preparators, clerks, typists, and stenographers in Washington and carpenters and laborers at the warehouse shops. The department's participation at the Sesquicentennial International Exposition consisted of five carloads of material, representing the scientific results developed by its investigators, and at the Third World's Poultry Congress of two carloads of exhibits portraying the latest information concerning the poultry industry.

FINANCIAL COOPERATION

The financial cooperation between the department and the fairs and expositions during the year resulted in total special deposits of $6,924.50 received from 46 fairs and expositions. These special contributed funds, which are deposited to cover the cost of transporting and installing exhibits. were received from depositors in 29 States and the District of Columbia. The cost to the department for participation in fairs and expositions was approximately $110,095, and with the addition of the special contributed funds of $6,924.50 makes a total for exhibit activities at 67 showings of $117,019.50.

In addition to regular funds, a special congressional appropriation of $20,000 was provided for participation by the department at the Third World's Poultry Congress, held in Ottawa, Canada, July 27 to August 4, 1927. Of this appropriation, $9,658 was spent during 1927 to cover cost of preparation.

EXHIBITION DIVISION

The efficiency of the exhibition division was increased by the installation of a current card index in which is recorded information regarding exhibition negotiations and showings as it develops. A new form of exhibition report was put into effect to insure uniformity in recording information on showings. From these reports the essential records are transferred to a cumulative report blank from which a summary of results can readily be made at any time.

The material handled in and out of the warehouse shops at Alexandria, Va., increased during the year by approximately eight carloads. Through the installation of an electric hoist the handling of the additional material has been accomplished without increased labor force. The hoist has also helped in making possible the large amount of shifting of material incident to annual renovation, without emergency labor. The efficiency of the carpenter shop was increased and a saving of time effected through the installation of new equipment.

List of exhibitions held during the fiscal year ended June 30, 1927

Place	Occasion	Dates
Amarillo, Tex.	Amarillo Tri-State Exposition	Sept. 21–27, 1926.
Asheville, N. C.	Western North Carolina Fair	Nov. 9–12, 1926.
Athens, Ga.	Cooperative Marketing School	Jan. 24–28, 1927.
Atlanta, Ga.	Southeastern Fair	Oct. 2–9, 1926.
Atlantic City, N. J.	Eastern States Tuberculosis Eradication Conference.	June 20–22, 1927.
Do.	National Canners' Association	Jan. 24–29, 1927.
Augusta, Me.	Highway Commission Fairs	Jan.–Sept., 1926.
Bangor, Me.	Maine State Highway Department	Aug. 23–27, 1926.
Birmingham, Ala.	Alabama State Fair	Oct. 4–9, 1926.
Blacksburg, Va.	Farmers' Institute	July 27–28, 1926.
Bolling Field, D. C.	Demonstration	May 2–6, 1927.
Boston, Mass.	New England Sportsmen's Show	Jan. 29–Feb. 5, 1927.
Brookhaven, Miss.	Seven-County Fair	Oct. 5–9, 1926.
Carthage, Mo.	Ozark District Fair	Aug. 3–6, 1926.
Chicago, Ill.	Chicago Road Show	Jan. 10–14, 1927.
Do.	International Livestock Exposition	Nov. 26–Dec. 3, 1926.
Do.	National Farm Bureau Exposition	Dec. 6–8, 1926.
Cleveland, Ohio.	National Cooperative Milk Producers' Association.	Nov. 10–11, 1926.
Columbus, Ohio.	Ohio State Fair	Aug. 30–Sept. 4, 1926.
Denver, Colo.	National Western Stock Show	Jan. 14–22, 1927.
Detroit, Mich.	National Dairy Exposition	Oct. 6–13, 1926.

List of exhibitions held during the fiscal year ended June 30, 1927—Continued

Place	Occasion	Dates
Des Moines, Iowa	Iowa State Fair	Aug. 25–Sept. 3, 1926.
Douglas, Wyo	Wyoming State Fair	Sept. 14–18, 1926.
Erie, Pa	Erie Exposition	Aug. 9–14, 1926.
Grand Rapids, Mich	West Michigan Fair	Aug. 30–Sept. 4, 1926.
Hamline, Minn	Minnesota State Fair	Sept. 4–11, 1926.
Harrisburg, Pa	Farm Products Show	Jan. 17–21, 1927.
Huron, S. Dak	South Dakota State Fair	Sept. 13–17, 1926.
Indianapolis, Ind	Indiana State Fair	Sept. 4–11, 1926.
Jackson, Miss	Illinois Central Train	Jan. 15–Feb. 15, 1927.
Jacksonville, Fla	Florida State Fair	Nov. 19–26, 1926.
Kansas City, Mo	American Royal Livestock Exposition	Nov. 13–20, 1926.
Lewiston, Me	Highway Department	Sept. 6–10, 1926.
Lincoln, Nebr	Nebraska State Fair	Sept. 5–10, 1926.
Little Rock, Ark	Arkansas State Fair	Oct. 11–16, 1926.
Louisville, Ky	Kentucky State Fair	Sept. 13–18, 1926.
Macon, Ga	Georgia State Exposition	Oct. 14–23, 1926.
Madison, Wis	Farmers' Day	June 10, 1927.
Memphis, Tenn	Memphis Tri-State Fair	Sept. 25–Oct. 2, 1926.
Moultrie, Ga	Moultrie Fair	Oct. 28–30, 1926.
Muskogee, Okla	Oklahoma Free State Fair	Oct. 2–9, 1926.
Nashville, Tenn	Tennessee State Fair	Sept. 20–25, 1926.
New Haven, Conn	Progress Exhibition	Jan. 26–Feb. 5, 1927.
Ohio	Baltimore & Ohio Train	June 6–18, 1927.
Philadelphia, Pa	Sesquicentennial International Exposition	June 1–Nov. 30, 1926.
Phoenix, Ariz	Arizona State Fair	Nov. 6–13, 1926.
Prescott, Ariz	Northern Arizona State Fair	July 1–5, 1926.
Pueblo, Colo	Colorado State Fair	Sept. 20–25, 1926.
Puyallup, Wash	Western Washington Fair	Sept. 13–19, 1926.
Reno, Nev	Transcontinental Highways Exposition	June 25–July 31, 1927.
Richmond, Va	Virginia State Fair	Oct. 4–9, 1926.
Rochester, N. Y	Rochester Exposition	Sept. 5–10, 1926.
San Francisco, Calif	All West Road Show	Oct. 7–15, 1926.
Sioux City, Iowa	Interstate Fair	Sept. 19–24, 1926.
Spokane, Wash	Spokane Interstate Fair	Sept. 6–11, 1926.
Topeka, Kans	Kansas Free Fair	Sept. 13–18, 1926.
Trenton, N. J	Trenton Interstate Fair	Sept. 27–Oct. 2, 1926.
Urbana, Ill	Farmers' Week	Jan. 17–21, 1927.
Waco, Tex	Texas Cotton Palace	Oct. 24–Nov. 8, 1926.
Washington, D. C	American Medical Association	May 16–20, 1927.
Do	Child Health Congress	May 9–11, 1927.
Do	International Soil Congress	June 13–22, 1927.
Waterloo, Iowa	Dairy Cattle Congress	Sept. 27–Oct. 3, 1926.
Waterville, Me	Maine State Highway Department	Aug. 31–Sept. 3, 1926.
Wichita, Kans	Southwest Road Show and School	Feb. 22–25, 1927.
Wichita Falls, Tex	Texas-Oklahoma Fair	Oct. 2–7, 1926.
Yakima, Wash	Washington State Fair	Sept. 20–25, 1926.

The showings at 34 fairs were arranged in 14 circuits, the same exhibit material going to all the fairs on a circuit. In addition, 31 special showings were made. The estimated attendance at all the showings in which the department participated is over 2,500,000.

In addition to five representatives from the office of exhibits, eight bureaus contributed the services of 22 representatives from time to time as they were needed for demonstration purposes at fairs. The number of days served by these circuit men ran from 10 to 62 days, the 27 men putting in a total of 777 days, or an average of 28.4 days.

PREPARATION DIVISION

During the year 72 exhibit units were completed, 6 were revised extensively, 175 were renovated and relettered, and 26 were under construction on June 30. These calculations are based upon the standard booth unit or its equivalent. This is the largest year's work produced so far. Compared with last year, 20 per cent more new booths were produced, 64 per cent more were renovated, and the same number were under construction at the close of the year.

At the beginning of the year an effort was made to follow a principle of fewer but better exhibits for the year's program. Added experience has made it possible to improve the exhibits, but insistent demands have made it impossible to reduce the number.

WORLD'S POULTRY CONGRESS

In addition to the regular work a large poultry exhibit was built for showing at the World's Poultry Congress at Ottawa, Canada, July 27 to August 4. The principal feature of the exhibit occupied about 3,000 square feet of floor space and took the form of a building 70 feet long and from 10 to 12 feet high. On the outside of

the structure were exhibits prepared by the department from material sent in by 22 State agricultural colleges. On the inside were three large rooms which displayed the exhibit material from the Department of Agriculture. Problems of poultry production were presented in one room, methods of marketing and utilization of products in another, and the development of the industry and present status in the third. Presentation methods included motion pictures, automatic lantern slide projectors, moving signs projected on screens in both English and French, still models, mechanically operated models, real objects, flashing lights, bulletin machines, and wax models. From comments and from observation of the effectiveness of the exhibit in drawing and holding spectators, it is believed that this was the most successful exhibit which the department has built so far. In addition to the exhibits described, the department presented teams of 4–H members from Nebraska, Vermont, Connecticut, and Michigan. These teams demonstrated daily the best practices in culling, sanitation, housing, and other phases of poultry production. A platform was provided for the demonstrators and chairs for the audience, the whole feature occupying 600 square feet of floor space. Adjoining the club feature was a combined office and conference room which served also as headquarters for American delegates and visitors.

EXHIBIT PRESENTATION METHODS

The use of new and novel methods of presentation is necessary in order to catch and hold the attention of visitors to fairs. Experiments are being tried in the use of talking figures in the exhibit for the National Dairy Exposition, the material to be presented having been prepared on phonograph records and reproduced with power amplifier and loud speaker. The record will appear to be a conversation between two manikins, which will make appropriate gestures as they talk.

Objects or mechanical effects difficult to produce are sometimes needed in department exhibits in considerable numbers. The desired effect can often be obtained through the placement or building of one unit and causing the observer to see several images of that unit by means of specially arranged mirrors.

Light colors have been used for backgrounds because they require less artificial lighting. It is difficult, however, to keep these light backgrounds clean and free from finger marks, and the paint obtainable will not stand frequent washing. Darker borders about 3 inches wide are now being used along the side, top, and bottom of the exhibit panels. Finger marks do not show on these darker areas, and opportunity is offered to introduce a variety of colors.

A new material called plastic wood has been used with success in making small models. This material can be modeled easily and when hard can be carved much like wood. It is light in weight and will stand more handling than wax or plaster.

COOPERATION WITH STATES AND INDUSTRIES

Due to an apparent increase in the use of exhibits, there has been a marked growth in cooperative work with State colleges, industries associated with agriculture, and individuals. Cooperation ranges from the planning of a complete exhibit for a State college to the mere furnishing of information on some exhibit topic. For example, complete exhibit plans were prepared on request for agricultural colleges in Virginia and New Hampshire, and plans for two railroad exhibit cars were worked out in cooperation with the exhibit representatives of the Colorado Agricultural College.

A particularly interesting project was that in which this office cooperated with a committee representing 12 Southern States which are preparing an exhibit called "Dairying in Dixie" for the National Dairy Exposition to be held at Memphis in October, 1927. Representatives of the office of exhibits met in a two-day session with a committee representing these States. Several conferences have since been held also with individual members of the committee working out particular problems connected with the preparation of a life-size mechanical cow, standardized exhibit background, and other features.

In connection with the World's Poultry Congress, 22 small exhibits were prepared from subject matter submitted by as many State colleges and experiment stations.

In addition to cooperation with State institutions there is a growing demand for information on exhibit construction, sources of material, and planning service on the part of industries and individuals. The correspondence and interviews involved in such transac-

tions are reaching proportions where serious consideration must be given to the amount of energy it is subtracting from the State fair work.

The work done by the engineering section continues to grow. Each year exhibits become more complicated in structure, lighting, and mechanical features. Several types of mechanical action have been designed or adapted to meet exhibit needs.

AGRICULTURAL INSTRUCTION IN SCHOOLS

The work of the office of agricultural instruction under the direction of E. H. Shinn followed the same general lines of development as during the last few years. It was largely concerned with investigation in methods of teaching agriculture in elementary and secondary schools and colleges and in making studies in the analyses of certain farm enterprises for the use of agricultural teachers. Active interest was also taken in extension education, and two surveys were made to determine what the land-grant colleges are doing in the professional preparation of students contemplating service in extension education in agriculture or home economics.

ILLUSTRATIVE MATERIAL FOR TEACHERS

Much time was given during the last year to the preparation of subject-matter material for the use of teachers. Suggestions frequently were made for the improvement of instructional methods, and much illustrative material for teachers was developed. The classified lists of publications of the department and sources of other materials that have proved to be beneficial to teachers in the past were enlarged and revised and were still being issued in large numbers. Close contacts were maintained by members of the staff with recent developments in agricultural and home-economics education that these lists might be of the greatest possible value. The object has always been not only to bring to the teachers the best of material, but also to keep teachers in close touch with the latest information available from the Department of Agriculture, the agricultural colleges, and experiment stations. In order to accomplish the greatest good along this line, close cooperation was maintained with the various subject-matter specialists of the department.

A total of 53 educational charts upon livestock and plants have been issued and circulated. These charts have been prepared in cooperation with the Bureau of Animal Industry, Plant Industry, and Agricultural Economics. Fourteen charts were recently revised for a second edition. New charts are being made continually, and at present 21 are in process of production. Requests for these charts came to the office from schools located all over the country, and the comments received relative to them are exceedingly favorable.

Lantern slides were distributed in many of the States. During the last few years there has been a large increase in the demand for lantern slides from agricultural teachers. Six new series of slides were completed and are in use. Each of these series has an accompanying circular that contains notes on the slides, which are helpful to teachers in presenting the subject. Much help in the preparation of these slides was obtained from the various bureaus of the Government and from outside agencies.

MANUSCRIPTS PREPARED

In cooperation with the Federal Board for Vocational Education an analysis of the operative jobs in a corn-growing enterprise was completed. This analysis is in the hands of the printer. A study of the activities included in extension projects in rural community organization in several States was completed. This report was issued as Extension Service Circular 43. Judging Dairy Cattle, Miscellaneous Circular No. 99, was completed and issued in collaboration with the Bureau of Dairy Industry. Considerable progress was made during the year on an activity analysis of the home maker's work from the managerial standpoint. It is the aim in this analysis to aid in developing the scope and content of extension work in home-management projects. Considerable work was also done on a study of the nature of meetings held in the several States in which rural social activities have been featured as extension work. References were collected and partially classified. This study is aimed to furnish help to extension workers and leaders in rural social organization work.

Aid was given to school superintendents, agricultural teachers, and other rural teachers in giving agricultural instruction to country boys and girls. Outline courses in elementary

agriculture were prepared for teachers. This work was done in a number of States at the request of the State superintendent of education, in cooperation with the agricultural colleges. This assistance to teachers has become so well established that many teachers receive from the department through this office publications, illustrative material, and other information useful in teaching agriculture and other subjects.

A mimeographed bulletin entitled "Does Education Pay the Farmer" was issued during the year, and attracted much favorable comment.

In collaboration with the Bureau of Plant Industry and others a publication entitled "Bread or Barberries" was completed and is ready for the printer. This story is intended for members of boys' and girls' clubs, students in the lower grades of grammar school, and adult farmers in States where the barberry is a pest. The bulletin is written in simple language and designed especially for boys and girls of public-school age. Following rather closely the aim and style of "Bread or Barberries," a story on the cotton-boll weevil and methods for its eradication is being written. This work was done in collaboration with specialists in the Bureau of Entomology. The manuscript is nearly completed and will be ready for publication within a short time.

Considerable work was done by the office for the committee on instruction in agriculture, home economics, and the mechanic arts of the Association of Land-Grant Colleges. A representative of the office acts as secretary of the committee, assembles the material on which its reports are based, and drafts the report for the consideration of the committee at its annual meeting.

MEETINGS ATTENDED

Some member of the staff attended each of the more important agricultural and rural education meetings of the last year. Conferences were held with leaders in the various fields of rural education with the aim of extending the services of the office. Conferences were also held at different times during the year with deans and professors of many land-grant colleges concerning teaching methods and ways and means of increasing teaching efficiency. Members of the staff attended and participated in the programs of such meetings as the American Country Life Association, American Vocational Education Association, and regional conferences on vocational education. Attendance at such meetings and conferences enables the staff to keep in close touch with the latest development in these fields. Close contact is maintained with all agencies working in the interest of agricultural education and rural development, with the aim of supplying the workers with such available material of the department as may be considered of value in their work.

U. S. GOVERNMENT PRINTING OFFICE: 1927

JAN

REPORT OF THE FEDERAL HORTICULTURAL BOARD

United States Department of Agriculture,
Federal Horticultural Board,
Washington, D. C., October 13, 1927.

Sir: I submit herewith an executive report covering the administration of the plant quarantine act for the fiscal year ended June 30, 1927.

Respectfully,

C. L. Marlatt, *Chairman.*

Hon. W. M. Jardine,
Secretary of Agriculture.

INTRODUCTION

During the year the board lost by death (May 10, 1927) George Bishop Sudworth, who had been with the board since its organization as the representative of the Forest Service of the department. This vacancy has not yet been filled.

The selection by the Bureau of Plant Industry of R. Kent Beattie, of the board's staff, to make a study of the chestnut blight disease in the Orient, with the object of securing and introducing into the United States a blight-resistant chestnut, left vacant the position of chief of the board's office of foreign-plant quarantines, a very important branch of the work, which Mr. Beattie had filled very satisfactorily for several years. This situation, together with the rapid growth of the work of the board, was the basis for a reorganization during the year of the board's central administration. The reorganization follows the two main fields of work under the plant quarantine act, and provides for (1) a branch of foreign-plant quarantines, and (2) a branch of domestic-plant quarantines. E. R. Sasscer, long associated with the board in important capacities, has been placed definitely in charge of the branch of foreign-plant quarantines, and assists the board in the enforcement, at the ports of entry and elsewhere in the United States, of some 22 foreign-plant quarantines restricting, controlling, and safeguarding entry of plants and plant products known to be carriers of specific plant enemies. S. B. Fracker, who for several years has been State entomologist of Wisconsin, has been placed in charge of the branch of domestic-plant quarantines, and will assist the board in the enforcement of some 19 domestic-plant quarantines for the prevention of spread of important new pests within the United States, and between the Territories of Porto Rico and Hawaii and the mainland of the United States.

It should be noted that the original field of the Federal Horticultural Board has been considerably broadened and enlarged both by amendments to the act and by related legislation of Congress—the latter including the legislation providing for the Mexican-border inspection and control, and for export certification. The board is also charged by the Secretary with the enforcement of the insect pest act of 1905, and cooperates with the Post Office Department in the enforcement of the terminal inspection act of 1915. The bulk of the work of the board, however, falls under the plant quarantine act and the closely related Mexican border act. Under the export certification act, certification of export products is made in accordance with the requirements of foreign countries. The more important of these activities are discussed in this report.

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REPORT OF THE FEDERAL HORTICULTURAL BOARD

UNITED STATES DEPARTMENT OF AGRICULTURE,
FEDERAL HORTICULTURAL BOARD,
Washington, D. C., October 13, 1927.

SIR: I submit herewith an executive report covering the administration of the plant quarantine act for the fiscal year ended June 30, 1927.

Respectfully,

C. L. MARLATT, *Chairman.*

Hon. W. M. JARDINE,
Secretary of Agriculture.

INTRODUCTION

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The tables included in this report have been carried in the annual reports of this board over a considerable series of years, and constitute a continuing record, not available elsewhere, of distinct reference value. One series of these tables gives a summary of the results of the enforcement of the various quarantines in the interception and exclusion from the United States of important new crop pests—insect and disease. Other tables record the importations of the plants and plant products, the entry of which is restricted and safeguarded under the various foreign quarantines.

As indicated in previous reports, the quarterly Service and Regulatory Announcements published by the board constitute a permanent record of the new quarantines and of revisions and modifications of those already in force. The final number of these announcements for each year contains a complete annotated list of the current quarantines, domestic and foreign, as well as other restrictive orders.

ENFORCEMENT OF FOREIGN-PLANT QUARANTINES

The enforcement of the restrictions on the entry of plants and plant products under the various foreign quarantines which have been promulgated by the department for the purpose of excluding new and dangerous pests to American agriculture, necessitates control at substantially all the ports of entry in the United States. The board receives very important cooperation in this work from the Customs Service and from the Post Office Department—the latter in connection with parcel-post importations. Very material aid is also rendered by the State Department, through the agency of the diplomatic and consular officers of the United States, and for the use of such officers the board has recently prepared, for distribution by the State Department, an annotated list of plants and plant products the entry of which into the United States is restricted or prohibited. This list is to enable diplomatic and consular officers to determine quickly the restrictions relative to any plants or plant products and in the briefest form the nature of the restrictions and the particular plant pest—disease or insect—which is the basis of the quarantine.

Inasmuch as full descriptive matter relative to the foreign quarantines enforced by this department is available elsewhere, it is unnecessary to list or discuss them particularly in this report, other than the summary, which has been given yearly, of new quarantines and amendments of old quarantines (p. 34). It is, however, desirable to include, as in former years, a record of the inspection work which is done at ports of entry and elsewhere in the United States in the enforcement of these quarantines, and of the importations of restricted plants and plant products. These features are discussed below under the respective titles of "Plant quarantine inspection" and "Records of imports of restricted plants and plant products."

PLANT QUARANTINE INSPECTION

This work relates, for the most part, to the enforcement at maritime, interior, and Mexican border ports of entry, of foreign quarantines and regulatory orders which govern the entry into this country of plants and plant products, and involves: (1) The inspection of vessels arriving at ports of entry from foreign ports and from Porto Rico and Hawaii; (2) the inspection and disposition of all plants and plant products under restriction found in passengers' baggage by the United States customs officials; (3) the inspection of all plants and plant products, including nursery stock, seeds, bulbs, fruits, and vegetables entered under permit from all foreign countries and localities and certain products arriving from domestic territory; (4) disinfection (fumigation or sterilization) of cotton and broomcorn and other products requiring such treatment as a condition of entry; (5) inspection, in cooperation with customs and post-office officials, of restricted plants and plant products arriving by foreign parcel post; (6) inspection of plants and plant products introduced by the Department of Agriculture and all plants imported under special permit in accordance with the provisions of regulation 14, quarantine 37; (7) inspection of plants (domestic) entering and leaving the District of Columbia; (8) inspection of plant-introduction gardens of the Bureau of Plant Industry; and (9) inspection of fruits and vegetables in the field and at the point of shipment in Porto Rico, in accordance with the provisions of quarantine 58. In addition, this service also inspects and certifies export fruit and vegetables to meet the sanitary requirements of certain foreign countries. The more important features of this inspection work are summarized below.

MEXICAN BORDER SERVICE

Inspectors of the board are now stationed at 10 ports of entry along the Mexican border; namely, Brownsville, Hidalgo, Laredo, Eagle Pass, Del Rio, and El Paso, Tex.; Douglas and Nogales, Ariz.; Calexico and San Ysidro, Calif. The ports of San Ysidro and Hidalgo were added during the year. Prior to July 1, 1926, the board had been represented at Tia Juana (name since changed to San Ysidro) by two customs inspectors acting as collaborators, but due to the increased traffic and other conditions at that port, it was deemed advisable to place a full-time inspector there at the beginning of the fiscal year. The customs inspectors have continued to act as collaborators and have rendered valuable assistance in the enforcement of the various plant quarantines and regulations. The completion of a bridge across the Rio Grande at Hidalgo, Tex., also made it necessary to place an inspector at that port. The amount of contraband fruits, some of which were infested with the maggots of the Mexican fruit worm, intercepted at Hidalgo since May 9, 1927 (the date the port was opened) fully justifies the placing of an inspector there.

During the early part of 1927 the railroad between Tepic, Nyarit, and Guadalajara, Jalisco, Mexico, was completed, thus making direct connection between the west coast and the interior of Mexico. Prior to the completion of this railroad the west coast had been more or less isolated from the interior of Mexico and apparently has been free from both the pink bollworm and the Mexican fruit worm. Conditions now are more favorable for both these pests reaching the west coast, necessitating greater precautions at the ports of entry in Arizona and California.

The border activities taken as a whole show an increase over the previous fiscal year. At the six ports having rail connections with Mexico, a total of 36,954 freight cars were inspected in the Mexican railway yards, 33,442 entered, and 18,911 were fumigated as a condition of entry. Three thousand and twenty-one cars were found to be contaminated with cottonseed, a decrease of 472 cars from the previous year. Four cars, all at the port of El Paso, were found contaminated with cottonseed which contained larvae of the pink bollworm. A charge of $4 is made for each car fumigated, and all fees collected are turned into the Treasury as miscellaneous receipts. A record of this work is given in Table 1.

TABLE 1.—*Inspection and fumigation of railway cars crossing the border from Mexico, fiscal year 1927* [1]

Port	Cars inspected	Cars entered	Cars with cottonseed	Cars fumigated	Fees collected
Brownsville	412	412	157	409	$1,636
Laredo	9,940	8,091	1,231	8,091	32,412
Eagle Pass	3,686	3,074	1,047	3,074	12,200
El Paso	9,614	8,815	336	4,397	17,600
Nogales	12,058	11,806	146	2,940	11,760
Douglas [2]	[3] 1,244	1,244	104	0	0
Total	36,954	33,442	3,021	18,911	75,608

[1] This table does not include the work performed at Del Rio, Tex., since there is no railway connection with Mexico at that point. Inspectors at this port inspected 25,320 vehicles of various descriptions, 28 of which were found contaminated with cottonseed and were fumigated as a condition of entry. Fees amounting to $14 were collected and turned into the Treasury.

[2] No fumigation facilities at this port.

[3] Does not include 1,439 Mexican gondolas which crossed to the smelter, were unloaded, and returned to Mexico.

In addition to the inspection, certification, and fumigation of railway cars from Mexico, the board's inspectors cooperate with the Customs Service in the inspection of baggage, personal effects, parcel-post, and express packages from the same country. A total of 65,576 pieces of baggage and 4,460 parcel-post packages were examined. In addition to the baggage mentioned, 948 mattresses, 1,144 pillows, and 2,304 quilts, many of them in the possession of laborers going into the cotton districts of this country, were found to be stuffed with raw cotton or seed cotton and were sterilized with live steam under pressure before entry was permitted. Table 2 indicates, either by

pounds or by individual units, contraband material intercepted in the possession of individuals crossing the Mexican border. There was a considerable increase over the previous year in the amount of fruit and vegetables entering under permit. In addition to large quantities of certain fruits and vegetables which are entered for local consumption under the inspector's permit, 962 cars of bananas and 5 cars of bananas, pineapples, and tomatoes mixed, entered at El Paso. At the port of Nogales, 4,521 cars of tomatoes, 1,478 cars of vegetables, 190 cars of bananas, 67 cars of cantaloupes, and 33 cars of watermelons were inspected and entered.

TABLE 2.—*Contraband plants and plant products intercepted at Mexican border ports, fiscal year 1927*

[Unless otherwise stated, the figures in the columns under number indicate the number of specimens intercepted]

Commodity	Brownsville		Del Rio		Douglas		Eagle Pass		El Paso		Laredo		Nogales		San Ysidro		Hidalgo [1]		Total	
	Interceptions	Number	Interceptions	Number	Interceptions	Number	Interceptions	Number	Interceptions	Number	Interceptions	Number	Interceptions	Number	Interceptions	Number	Interceptions	Number	Interceptions	Number
Apples	50	685	5	30	154	371	127	792	558	2,416	344	1,582	149	1,208	22	126	5	8	1,414	7,218
Apricots	4	70	---	---	15	178	---	---	8	323	3	608	2	136	27	608	1	18	60	1,941
Avocados	80	746	4	26	5	10	66	400	233	838	286	800	25	281	40	95	49	270	788	3,466
Avocado seeds	---	---	1	3	1	2	8	91	57	164	146	352	8	203	2	56	8	13	231	884
Bulbs	---	---	---	---	12	54	---	---	8	32	---	---	---	---	---	---	---	---	20	86
Cherimoyas	4	5	---	---	---	---	3	5	30	42	30	105	1	2	---	---	---	---	68	159
Cherries	---	---	---	---	---	---	---	---	---	---	---	---	9	384	11	288	---	---	20	672
Corn, ears	9	106	10	97	---	---	---	---	98	425	---	---	---	---	18	125	1	38	136	791
Cornstalks	5	220	14	57	1	40	1	10	---	---	36	50	7	127	---	---	---	---	64	504
Corn husks ..lbs..	9	13	47	26½	18	48	27	56	38	89½	26	41	51	118	2	13	---	---	218	404¾
Corn, shelled ..lbs..	11	295	37	61¼	47	322	49	175	82	396	108	296	69	329	1	8	---	---	404	1,882¼
Cotton bolls	8	103	---	---	---	---	---	---	17	40	1	15	5	220	2	34	---	---	33	412
Cotton lint ..lbs..	3	6	---	---	2	2	3	10½	69	51¼	22	63	31	56	3	6	---	---	133	194¾
Cottonseed ..lbs..	4	½	27	10	---	---	2	8	44	74	6	6	1	2	---	---	---	---	84	100½
Dates, fresh	---	---	---	---	4	98	---	---	---	---	---	---	9	650	1	48	---	---	14	796
Figs	3	31	7	286	5	347	78	6,468	66	777	103	1,780	19	2,130	13	360	1	23	295	12202
Grapefruit	43	159	1	6	2	3	3	6	4	4	18	36	48	136	11	44	1	1	131	395
Guavas	5	53	5	39	---	---	23	400	136	711	107	792	15	400	4	90	---	---	295	2,485
Limes, sweet	4	33	---	---	15	36	7	172	113	488	116	768	57	828	---	---	---	---	312	2,325
Mameys	25	50	1	3	---	---	4	6	141	237	89	392	5	14	---	---	1	6	266	708
Mangoes	52	210	4	7	38	95	31	160	204	545	192	696	38	795	154	750	27	104	740	3,362
Oranges	110	566	12	27	234	498	159	728	673	1,591	613	2,925	258	1,932	108	1,053	15	28	2,182	9,348
Orange leaves ..lbs..	---	---	---	---	13	15	---	---	10	5¾	9	16	---	---	---	---	---	---	32	36¾
Papayas	3	16	---	---	---	---	---	---	---	---	---	---	11	20	---	---	---	---	14	36
Peaches	3	101	19	1,209	65	409	53	774	138	1,197	88	390	55	1,526	11	152	---	---	432	5,758
Pears	4	226	8	73	36	139	11	48	120	493	86	300	19	99	3	52	1	2	288	1,432
Persimmons	1	6	---	---	---	---	---	---	3	9	3	10	3	27	2	6	---	---	12	58
Plants	76	1,098	30	158	59	902	71	231	338	2,276	304	2,780	340	994	118	1,196	11	89	1,347	9,724
Plums	2	49	1	34	5	322	1	6	30	608	24	108	32	755	12	210	---	---	107	2,092
Pomegranates	7	52	10	43	10	24	43	458	45	137	112	582	89	460	8	55	1	5	325	1,816
Potatoes	3	2,513	1	10	---	---	24	398	117	2,446	45	792	---	---	5	90	2	20	197	6,269
Potatoes, sweet	4	79	4	106	27	275	32	230	92	1,098	16	116	83	640	3	30	1	13	262	2,587
Prunes	---	---	---	---	1	40	---	---	---	---	---	---	---	---	1	32	---	---	2	72
Quinces	3	85	6	64	90	145	54	604	149	430	117	785	65	827	1	3	---	---	485	2,943
Sapotes	3	5	1	1	---	---	---	---	21	48	---	---	4	48	1	6	---	---	40	108
Sorghum stalks	5	172	3	8	3	15	1	10	24	32	3	20	33	101	1	1	---	---	73	359
Sugar cane, stalks	9	55	21	57	47	60	83	192	202	560	93	250	---	---	18	25	---	---	473	1,197
Tangerines	4	25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4	25
Tejocotes	---	---	---	---	5	232	---	---	9	580	---	---	---	---	---	---	---	---	14	812

[1] Report covers period May 7, 1927 (date port was opened) to June 30, 1927.

INSPECTION OF VESSELS

Vessels arriving from foreign ports as well as from Hawaii and Porto Rico are boarded promptly upon arrival, and a search is made for contraband plants and plant products in the staterooms, ice boxes, fruit and vegetable lockers, and passengers' and crews' quarters. All plants and plant products intercepted by the customs inspectors in passengers' baggage are turned over to representatives of the board for disposition. During the year under review 6,742 plants and plant products were thus intercepted at maritime ports and disposed of. Full-time inspectors are now stationed at the more important ports of entry with the exception of those located in California, Florida, Alabama, Mississippi, Georgia, Hawaii, and Porto Rico, which States and insular possessions maintain plant quarantine inspection services. These inspectors serve as collaborators of the board at a nominal cost and have rendered very efficient service. This work is in addition to the cargo, parcel post, and export inspection subsequently referred to.

TABLE 3.—*Ships inspected during fiscal year 1927*

Port	Number arrived				Number inspected				Number on which contraband was found							
									Ships' stores				Officers' and crews' quarters			
	Foreign	Coastwise	Porto Rico	Hawaii	Foreign	Coastwise	Porto Rico	Hawaii	Foreign	Coastwise	Porto Rico	Hawaii	Foreign	Coastwise	Porto Rico	Hawaii
Astoria	590	1,226	0	10	249	25	0	6	35	0	0	1	36	0	0	2
Baltimore	1,332	859	36	4	951	251	18	4	607	75	6	0	21	5	0	0
Boston	1,357	242	14	0	1,119	182	14	0	605	58	6	0	10	0	0	0
Charleston	225	360	0	0	[1] 251	66	0	0	116	16	0	0	14	3	0	0
Detroit (4 months)	[2] 245															
Galveston	608	682	6	0	606	6	6	0	260	0	4	0	16	0	0	0
Houston	177	702	0	0	177	634	0	0	21	2	0	0	0	0	0	0
Jacksonville [3]	159	1,385	4	0	159	1,385	4	0	75	1,261	3	0	2	0	0	0
Key West [3]	1,041	327	0	0	1,041	327	0	0	11	0	0	0	0	0	0	0
Miami [3]	780	475	0	0	779	0	0	0	0	0	0	0	0	0	0	0
Mobile [3]	161	0	4	0	161	0	4	0	79	0	0	0	8	0	0	0
New Orleans	2,247	1,107	18	7	2,186	150	18	7	912	51	7	1	458	0	0	0
New York	4,740	4,264	219	0	4,116	624	193	0	3,352	0	77	0	11	0	24	0
Pensacola [3]	118	361	0	0	140	361	0	0	94	54	0	0	1	0	0	0
Philadelphia	1,298	1,752	36	0	1,128	816	36	0	665	378	14	0	245	33	6	0
Portland, Oreg.	155	353	0	6	155	353	0	6	81	129	0	1	17	4	0	0
San Diego [3]	1,375	401	0	2	1,375	401	0	2	19	0	0	0	29	0	0	0
San Francisco [3]	484	2,322	0	267	484	2,322	0	267	0	0	0	0	0	0	0	0
San Pedro [3]	1,904	2,177	1	51	1,641	2,394	3	51	209	22	0	0	48	4	0	2
Seattle	2,683	2,561	0	11	1,031	320	0	11	195	51	0	3	2	0	0	0
Tampa [3]	527	742	5	0	527	742	5	0	379	320	5	0	38	18	0	0
Total	22,206	22,298	343	358	18,276	11,359	301	354	7,715	2,417	122	6	956	67	30	4

[1] 26 foreign ships put in at Charleston for bunkers and were inspected by Federal Horticultural Board inspector but were not entered by customs.
[2] From Canadian ports only.
[3] Collaborators stationed at these ports.

CARGO INSPECTION

All cargoes subject to plant quarantine restrictions, with the exception of special-permit plant material imported under regulation 14 of quarantine 37, which is examined in Washington, D. C., or San Francisco, Calif., are inspected at the port of entry or port of first arrival. A total of 29,595 shipments was offered for entry and inspection, 29,332 of which were admitted and 263 denied. For record of commercial entries of restricted plants and plant products, see pages 9–24. Tables 9 to 24 indicate the wide range of products which are subject to restriction. Many of these shipments are, as a condition of entry, disinfected at the port of first arrival, such as foreign cotton lint, cotton waste, certain types of bagging, and broomcorn. In addition, narcissus bulbs are given the hot-water treatment at point of destination, under the supervision of representatives of the board. Moreover, considerable time is devoted to the supervision of the cleaning by the importers of products contaminated with objectionable material.

Table 4 indicates the volume of this inspection, by ports.

TABLE 4.—*Inspections of shipments of plants and plant products offered for entry fiscal year 1927*

Port	Number of shipments requiring inspection	Number of shipments refused entry	Number of interceptions		Port	Number of shipments requiring inspection	Number of shipments refused entry	Number of interceptions	
			Insects	Diseases				Insects	Diseases
Astoria	0	0	0	0	New York	15,948	121	1,195	260
Baltimore	294	0	70	24	Pensacola [2]	0	0	1	0
Boston	2,296	1	404	135	Philadelphia	953	10	311	298
Charleston	65	4	17	7	Portland, Oreg	184	2	34	20
Chicago	99	0	7	2	St. Louis	69	0	6	1
Detroit [1]	57	7	3	2	San Diego [2]	168	58	1	0
Galveston	127	5	15	0	San Francisco [2]	1,858	24	319	1
Houston	129	0	0	0	San Pedro [2]	1,651	4	39	0
Jacksonville [2]	2	0	1	0	Seattle	796	5	185	21
Key West [2]	1,275	0	0	0	Tampa [2]	678	2	1	0
Miami [2]	55	0	0	0					
Mobile	200	0	16	0	Total	29,595	263	2,886	784
New Orleans	2,691	20	261	13					

[1] Representative of board stationed at Detroit, March, 1927.
[2] Collaborators stationed at these ports.

INSPECTION OF SPECIAL-PERMIT AND DEPARTMENTAL IMPORTATIONS

Ninety-five per cent of all plants imported under special permit are examined in Washington. This includes all introductions from Europe via eastern and other ports, except San Francisco, and amounts to a very large volume of material. Some 60,000,000 plants have been thus entered since 1919. A tabular record of the special-permit material is given on pages 14–16. The only other port of entry for such material is San Francisco, to cover entries made from trans-Pacific countries and destined for Pacific coast or other western points. Washington is also the port of entry for a good deal of other restricted material, as, for example, all parcel-post shipments. Under the plant quarantine act also the Federal Horticultural Board is made the administrative agency for the enforcement of domestic plant quarantines with respect to the District of Columbia. An important additional feature of the work is the handling of all the plant importations made by, or through, the United States Department of Agriculture.

TABLE 5.—*Summary of plants and plant products offered for inspection in the District of Co umbia, fiscal year 1927*

Material inspected	Foreign	Domestic	Fumigated	Otherwise treated	Infested with insects [1]	Infected with diseases
Lots of plants and plant products (departmental)	*Number* 7,314	*Number* 3,815	*Number* [2] 8,218	*Number* [2] 5,207	*Number* 483	*Number* 136
Shipments of plants under regulation 14, quarantine 37 (commercial)	[3] 1,100	----------	126	38	156	204
Shipments of plants under regulations 3 and 15, quarantine 37 (commercial)	[4] 724	----------	[5] 3,834	61	21	12
Containers of domestic plants (mail, express, and freight)	----------	10,536	----------	----------	----------	----------
Shipments of plants for distribution by United States Botanic Garden	----------	4,764	----------	----------	----------	----------
Shipments of plants by private individuals	----------	243	----------	----------	18	8
Interceptions of plants and plant products referred to Washington [6]	841	----------	239	14	17	18
Cotton samples referred to Washington	13,584	----------	13,584	----------	----------	----------

[1] This indicates the number of lots or shipments found to be infested, and not the number of species of insects collected. Some shipments were found to contain several species of insects.
[2] The apparent excess in the number of lots of plants and plant products (departmental) fumigated and otherwise treated over the number of lots received is caused by giving treatments in addition to fumigation.
[3] 2,274 containers.
[4] 1,003 containers.
[5] This figure represents the number of lots in the shipments which were fumigated.
[6] These interceptions represent plants and plant products arriving by mail without permits.

FOREIGN PARCEL-POST INSPECTION

In addition to the entry under permits duly issued of restricted plants by parcel post, discussed in the previous section, the inspectors of the board at ports of entry and other points throughout the United States where inspectors are stationed cooperate with the Postal and Customs Services in the inspection and safeguarding of the very considerable volume of such restricted plant material received through the mails not under permit. Where such material is possible of entry under the quarantine, it is sent to Washington for inspection, to be later forwarded to the addressee. Articles which are not subject to such entry are returned to point of origin or destroyed. Mail packages arriving at ports where there are no representatives of the board are dispatched to the nearest port at which inspectors are stationed. Exclusive of packages containing shamrocks with soil removed and the so-called sacred lemon (*Citrus medica*), 10,666 packages were inspected. Of this number, 3,628 contained contraband material.

INSPECTIONS IN HAWAII AND PORTO RICO

Similar port and ship inspection service is carried out under the authority of the plant quarantine act at the ports of entry of the Territories of Hawaii and Porto Rico.

In Hawaii the enforcement of the Federal quarantines and the necessary port-inspection work is conducted by the Territorial Government in cooperation with the United States Department of Agriculture under the same arrangement which is in effect with respect to California and Florida. In addition, the board is charged, in cooperation with the Bureau of Entomology, with the inspection and certification of fruits and vegetables shipped from Hawaii to the mainland of the United States.

A similar plan of cooperation with the Territorial Department of Agriculture is followed in the case of Porto Rico as to port inspection. The board, however, does maintain in Porto Rico an inspection unit to aid in the enforcement of quarantine No. 58 (domestic), which controls the movement of fruits and vegetables from that island to the mainland of the United States. The inspection and certification of such exports is being made by the board in Porto Rico prior to shipment to the coast, with the object of avoiding delays of perishable material at port of entry. The inspectors stationed in Porto Rico make repeated examinations of the fruits and vegetables in the fields, groves, and packing houses, as a basis for the issuance of certificates. A total of 5,476 shipments was inspected and certified, involving 1,613,483 containers. A summary (by containers) of the fruits and vegetables examined and certified for shipment to the mainland is given in Table 6.

TABLE 6.—*Fruits and vegetables inspected and certified for shipment from Porto Rico to the mainland, fiscal year 1927*

[By containers]

Commodity	July	August	September	October	November	December
Grapefruit	9,594	40,584	159,672	157,826	73,401	3,595
Pineapples	15,571	10,926	4,230	62,213	11,940	7,202
Oranges	54	1,161	3,364	4,878	68,796	18,416
Peppers	130	40			35	553
Eggplants						177
Tomatoes					56	1,821
Dasheens	39	45	56	21	55	253
Tangerines			1	1	234	391½
Citrons	102	90	82	77	76	34
Plantains	355	303	9	3	12	27
Pumpkins					143	189
Ginger root	169	46	33	33	48	11
Cucumbers				15	35	200
Mixed fruits	6	21	1	3	41	166½
Lemons				149	53	
Limes	47	12	4			
King oranges					31	2
Avocados	2	18	10	1	5	
Bananas	16					2
Mandarins						2
Total	26,085	53,246	167,462	225,220	154,961	33,042
Certificates issued	246	296	302	437	519	368

TABLE 6.—*Fruits and vegetables inspected and certified for shipment from Porto Rico to the mainland, fiscal year 1927*—Continued

Commodity	January	February	March	April	May	June	Total
Grapefruit	3,479	17,836	12,025	26,798	70,289	101,684	676,783
Pineapples	13,870	7,307	36,343	181,950	246,936	44,389	642,877
Oranges	7,535	46,080	51,217	47,966	6,534	16	256,017
Peppers	2,234	2,114	2,225	1,463	2,061	284	11,139
Eggplants	1,683	2,911	3,540	1,184	364	82	9,941
Tomatoes	1,945	2,468	2,880	202			9,372
Dasheens	178	250	288	187	229	140	1,741
Tangerines	581	57½	4				1,270
Citrons	18	53	13	110	170	202	1,027
Plantains		12	7	26	17		771
Pumpkins	58	93	69	24	15	52	643
Ginger root	43	1	33	69	32	50	568
Cucumbers	24	57		1	26	20	378
Mixed fruits	25	44	31	15	17½	4	375
Lemons							202
Watermelons	31	4	55	12	29		131
Limes					8	32	103
King oranges			7			4	44
Summer squash			38				38
Avocados							36
Bananas			1		2		21
Mandarins	2	2					6
Total	31,706	79,289½	108,776	260,007	326,729½	146,959	1,618,478
Certificates issued	355	465	526	678	836	448	5,476

INSPECTION OF PLANT INTRODUCTION AND PROPAGATING GARDENS

As formerly, all plants distributed by the Bureau of Plant Industry from its field introduction and propagating gardens were inspected and certified prior to shipment. All plants so certified were examined by inspectors of the Federal Horticultural Board with the exception of those distributed from the Mandan and Chico gardens, which were inspected by officials of the States of North Dakota and California, respectively. The inspection by State officials of the plants distributed from these outlying stations effects a considerable saving to the board in the form of transportation. Table 7 indicates the number of plants inspected and certified for distribution.

TABLE 7.—*Summary of plants and seeds examined for distribution from plant introduction and propagating gardens, fiscal year 1927*

Station	Plants	Packets of seeds	Bud sticks, cuttings, tubers, and roots
	Number	*Number*	*Number*
Bell, Md.	66,699	50	1,109
Chapman Field, Fla.	14,158	18	342
Chico, Calif.	23,605	285	7,950
Mandan, N. Dak.	194,415	0	16,700
Savannah, Ga.	16,488	0	100
Total	315,365	353	26,554

PESTS INTERCEPTED

During the fiscal year the inspectors and collaborators of the board collected on or in imported plants and plant products 556 recognized species and 473 insects which could be assigned to genera or families. These interceptions included a number of pests which are known to be injurious to agriculture, many of which at present do not occur in this country. Maggots of such injurious fruit pests as the Mediterranean fruit fly, the West Indian fruit fly, the melon fly, and the Mexican fruit worm were taken on a number of occasions in a wide variety of fruits arriving from a number of foreign countries. Chestnuts from Italy and Spain were repeatedly found to be infested with the so-called codling moth of Europe and species of chestnut weevils. The turnip gall weevil (*Ceutorhynchus pleurostigma*) arrived in turnips from France, Holland, and England. This insect, which is not known to occur in the United States, is reported to be very injurious to this crop at times. The West Indian sweet-potato weevil was intercepted on a number of occasions in sweet potatoes arriving from Porto Rico, Brazil, and Trinidad.

Such injurious insects as the pink bollworm of cotton, the European tussock moth, the brown-tail and gypsy moths, the European corn borer, the avocado weevil, the white tree pierid, the European earwig, and several species of wireworms were taken on several occasions. *Ustilago coicis*, a smut disease of *Coix lachryma-jobi*, a relative of corn, was intercepted on Coix seed from the Philippines. Wakker's hyacinth disease, or yellow slime disease, was intercepted on hyacinth bulbs from Holland. Several shipments of peonies from Holland and France were rejected in whole or in part, largely because of nematode infestations. Inasmuch as an annotated list of the insects and plant diseases intercepted in foreign plants and plant products is contained in the annual letter of information, published in the Service and Regulatory Announcements of this board, no attempt is made at this time to give a detailed account of these interceptions.

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TABLE 8.—*Total number of interceptions of insects and plant diseases at all ports, fiscal year 1927*

Port	Insects	Plant diseases
Astoria	37	31
Baltimore	130	57
Boston	761	217
Brownsville	5	5
Calexico	1	0
Charleston	170	137
Chicago	21	2
Del Rio	9	0
Detroit (4 months)	31	8
Douglas	37	1
Eagle Pass	15	0
El Paso	55	13
Galveston	25	3
Hidalgo (2 months)	1	0
Houston	0	0
Jacksonville [1]	31	32
Key West [1]	51	0
Laredo	25	3
Miami [1]	14	0
Mobile [1]	34	1
New Orleans	376	35
New York	1,623	356
Nogales	16	3
Pensacola [1]	25	25
Philadelphia	1,693	651
Portland	38	22
Providence	77	8
Seattle	433	69
St. Louis	21	4
San Diego [1]	15	0
San Francisco [1]	912	4
San Pedro [1]	124	4
San Ysidro	27	5
San Juan, Porto Rico	218	10
Tampa [1]	14	1
Miscellaneous	85	23
Total [2]	7,150	1,730

[1] Collaborators stationed at these ports.
[2] Of the 7,150 insect interceptions, 473 could be identified only to families or genera. The remaining 6,677 interceptions represent 556 recognized species and varieties.

RECORDS OF IMPORTS OF RESTRICTED PLANTS AND PLANT PRODUCTS

Under various foreign quarantines certain plants and plant products are restricted as to entry and made subject to inspection and, if necessary, disinfection, for the purpose of excluding various plant diseases and insect pests. Among these restricted plants and plant products are nursery stock, plants, and seeds for propagation, fruits and vegetables, grains from certain countries, broomcorn, and cotton, cotton waste, cotton wrappings, and cottonseed products. The records of

the importations of these articles are indicated in the following discussion and tables:

IMPORTATIONS OF NURSERY STOCK, PLANTS, AND SEEDS

The importations recorded in Tables 9, 10, 11, and 12 are entered under regulation 3 of quarantine 37, under permits which are made continuing and unlimited as to the quantity which may be imported. The restrictions under this regulation are intended merely to afford opportunity to inspect, and if necessary, safeguard the products as they are so entered. In the case of Table 9 the entries made in the preceding year are also listed for the purpose of comparison, and in Table 11 the bulb entries of the last eight years are brought together to show the fluctuation in the entry of different classes of bulbs.

TABLE 9.—*Importation of fruit, rose, and nut stocks, cuttings, and scions, under quarantine No. 37, year ended June 30, 1927*

[Figures indicate number of plants]

Kind of stocks, cuttings, and scions	Africa	Bulgaria	Canada	Cuba	Egypt	England	France	Germany	Greece	Holland
Apple			398			2,850	3,311,175	950		38,375
Cherry							6,865,850	300		8,620
Fig									100	
Grape	900	20,000					15,050	36	13	
Nectarine						42				
Nut			46				28,800	100		3,000
Olive					35					
Peach						48		5		
Pear							1,368,300	576		
Pineapple				50						
Plum							1,380,500	496		1,000
Quince							955,450	200		
Rose						3,274,430	2,160,800	200		6,331,080
Total	900	20,000	444	50	35	3,277,370	16,085,925	2,863	113	6,382,075

Kind of stocks, cuttings, and scions	Hungary	Ireland	Italy	Mexico	Portugal	Russia	Scotland	Syria	Total	
									1926–27	1925–26
Apple			357,000		12				3,710,760	4,926,409
Apricot	10								10	
Cherry	10								6,874,780	6,311,516
Fig			704						804	33
Grape	169,620		62,300			439		10	268,368	9,981
Nectarine									42	42
Nut			1	6					31,953	35,600
Olive									35	
Peach									53	48
Pear	10		100,105						1,468,991	3,857,707
Pineapple									50	
Plum			130,000						1,511,996	1,903,820
Pomegranate			50						50	
Quince			7,000						962,650	889,400
Rose		156,000	24,000				65,000		12,011,510	10,844,920
Total	169,650	156,000	681,160	6	12	439	65,000	10	26,842,052	28,779,476

TABLE 10.—*Importation of bulbs under regulation 3 of quarantine 37, year ended June 30, 1927*

[Figures indicate number of bulbs]

Bulbs	Africa	Australia	Azores	Belgium	Bermuda	Canada	China	England	France
Chionodoxa								1,012	
Convallaria						50		368	
Crocus								764	
Eranthis								56	
Fritillaria								37	
Galanthus								1,650	
Hyacinth					33			48	674,060
Ixia								202	
Lily		506	15,666	6,000	759,237		7,350	6,117	562,021
Muscari								1,448	
Scilla								1,545	
Tulip	500							963	41,250
Total	500	506	15,666	6,000	759,270	50	7,350	14,210	1,277,331

Bulbs	Germany	Holland	India	Ireland	Japan	Philippines	Russia	Scotland	Total
Chionodoxa		465,860							466,872
Convallaria	18,039,205	2,518,825		12					20,558,460
Crocus		9,968,188		118					9,969,070
Eranthis		144,094							144,150
Fritillaria		125,601		50					125,688
Galanthus		842,894							844,544
Hyacinth		23,037,037							23,711,178
Ixia		529,202							529,404
Lily	19,000	217,854	200	10	14,633,623	1,000	150	28	16,228,762
Muscari		991,891							993,339
Scilla	200	1,451,568		100,000					1,553,313
Tulip		129,638,323							129,681,036
Miscellaneous		11,112							11,112
Total	18,058,405	169,942,449	200	100,190	14,633,623	1,000	150	28	204,816,928

TABLE 11.—*Summary of bulb importations, regulation 3, quarantine 37, for the years 1919–20 to 1926–27*

[Figures indicate number of bulbs]

Bulbs	1919–20	1920–21	1921–22	1922–23	1923–24	1924–25	1925–26	1926–27
Chionodoxa [1]					339,766	465,422	839,637	466,872
Convallaria	9,964,847	3,606,746	14,951,170	19,603,092	17,568,835	18,980,311	20,543,785	20,558,460
Crocus	3,977,892	5,514,805	6,319,082	8,286,500	10,815.920	10,624,670	10,898,968	9,969,070
Eranthis [1]					93,314	152,787	214,173	144,150
Fritillaria [1]					92,951	104,483	209,543	125,688
Galanthus [1]					797,381	895,003	1,128,335	844,544
Hyacinth	16,375,494	22,568,891	24,808,236	29,142,797	32,197,740	27,947,261	23,682,560	23,711,178
Ixia [1]					335,158	371,983	545,278	529,404
Lily	14,538,936	22,490,533	8,219,460	9,145,630	9,690,486	11,207,559	16,031,090	16,228,762
Muscari [1]					612,329	906,259	1,404,573	993,339
Narcissus	56,032,918	77,956,195	77,270,548	77,193,281	92,659,666	106,314,049	142,384,199	
Scilla [1]					994,762	1,742,514	2,012,750	1,553,313
Tulip	49,972,184	55,075,343	64,846,940	76,719,116	92,539,157	96,290,452	106,849,572	129,681,036
Unclassified	1,653,790	4,756,369	70,750	183,900				11,112
Total	152,516,061	191,968,882	196,486,186	220,274,316	258,737,465	276,002,753	326,744,463	204,816,928

[1] Imported under special permit from June 1, 1919, to Jan. 1, 1923.

TABLE 12.—*Importation of tree seeds under quarantine No. 37, year ended June 30, 1927*

[Figures indicate number of pounds]

Country of origin	Apple	Apricot	Banana	Cherry	Grape	Nut and palm	Onion (sets)	Ornamental and tree	Pear	Persimmon	Plum	Quince	Raspberry	Rose	Strawberry	Miscellaneous	Total
Africa						14											14
Australia						31,780		30									31,810
Austria	3,238			4,215		35	1	18,544	1,637		110	10		30		306	28,126
Brazil						931		10									941
Canada	5							1,039								6	1,050
Canary Islands						37		27									64
Ceylon						33											33
Chile								388									388
China						791		2,140	648	111	1			30		346	4,067
Cuba						616										2	618
Czechoslovakia				500				1,628									2,128
Denmark								477								22	499
England						1,401		12									1,413
France	13,668		32	1,953		430		4,087	723	18	235		1		1	3	21,151
Germany	37			5				3,694	37		18	10		23			3,824
Greece							1,300										1,300
Holland								52								22	74
Honduras						115											115
Hungary							1									10	11
India						1,974		8								6	1,988
Ireland								2									2
Italy								638								2	640
Jamaica						5											5
Japan	34	32			9	1,244		7,889	3,377	262	12	21		752		3	13,635
Mexico			90			5		127									222
New Zealand						204		86									290
Philippine Islands								25									25
Poland								328				12					340
Portugal						2		2									4
Scotland						50		333									383
Straits Settlements						20											20
Sweden								1									1
Trinidad						605											605
Yugoslavia				960			28,175				4,299						33,434
Total	16,982	32	122	7,633	9	40,278	29,477	41,581	6,422	391	4,675	53	1	835	1	728	149,220

TABLE 13.—*Distribution by States of bulbs, nursery stock, and seeds imported under regulation 3 of quarantine 37, year ended June 30, 1927*

State	Bulbs	Stocks, cuttings, and scions			Seeds					
		Fruit	Rose	Nut	Fruit	Nut and palm	Onion (sets)	Ornamental and tree	Rose	Total
	Cases	*Number*	*Number*	*Number*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Alabama	272	55,000	2,000		71			870	10	951
Alaska	5									
Arizona	10			6				2		2
Arkansas	102					2				2
California	5,770	427,434	3,000		409	13,382		1,236	4	15,031
Colorado	778		76,250							
Connecticut	2,113	1,592,055	1,565,915	2,000	335	803		1,300	10	2,448
Delaware	214	93,000	4,000							
District of Columbia	600					60		2		62
Florida	162	50			2	2,748		1,414	13	4,177
Georgia	813	20,000			1,313	829		4,102	115	6,359
Idaho	330	30,000								
Illinois	23,663	107,600	1,761,630			1,264		3,705		4,969
Indiana	1,002	471,500	580,500			3		4		7
Iowa	1,042	3,019,200	388,620	2,500	529	27		571	15	1,142
Kansas	376	751,500			8,695			2,256		10,951
Kentucky	394							30		30
Louisiana	227					80		76		156
Maine	326							145		145
Maryland	1,106	130,015	66,500					1		1
Massachusetts	4,204	8,263	118,000			10		461	4	475
Michigan	3,562	595,800	177,750			13		115	24	152
Minnesota	1,698		35,000					291		291
Mississippi	158							3		3
Missouri	2,237	219,000	30,000	46	4,532	11	1	61		4,605
Montana	127									
Nebraska	348				45			210	1	256
Nevada	2									
New Hampshire	139							379		379
New Jersey	6,041	75	1,193,850		10	1,317	28,160	621	78	30,186
New Mexico	10									
New York	55,718	5,604,686	3,816,505	17,301	8,257	8,869	16	7,702	448	25,292
North Carolina	289	150,500			5	1		981		987
North Dakota	103		100			2		6	10	18
Ohio	5,621	789,066	1,715,790	8,000	6	277		493		776
Oklahoma	173	43,000	2,000							
Oregon	996	69,247			472	133		237		842
Pennsylvania	15,993	210,850	345,750	2,100	7,831	7,341	1,300	13,176	103	29,751
Rhode Island	1,192	8,000	3,250					145		145
South Carolina	98					6				6
South Dakota	68				1					1
Tennessee	922	244,000	20,000			52				52
Texas	611	75,100			575	348		244		1,167
Utah	175	37,700	10,000							
Vermont	246							165		165
Virginia	658	45,000	15,000		60	5		17		82
Washington	1,745				3,173	2,692		227		6,092
West Virginia	281	348								
Wisconsin	1,861	600	70,100					331		331
Wyoming	9									
Exported by permittee	283		10,000			3		2		5
Total	144,873	14,798,589	12,011,510	31,953	36,321	40,278	29,477	41,581	835	[1] 148,492

[1] Does not include 728 pounds of miscellaneous seeds.

The record of entry under special permits issued under the provisions of regulation 14 of quarantine 37 for the purpose of keeping the country supplied with new varieties and necessary propagating stock and to meet other technical and educational needs is given in Table 14.

TABLE 14.—*Special-permit importations, 1927, with combined total for the period 1920–1927*

Class of plant	Fiscal year 1927				Total, 1920–1927			
	Permits issued		Permits imported		Permits issued		Permits imported	
	Number	*Quantity*	*Number*	*Quantity*	*Number*	*Quantity*	*Number*	*Quantity*
Gladiolus	201	6,134,242	176	848,761	1,122	45,901,076	899	26,447,059
Dahlia	86	7,626	81	5,735	476	40,086	392	26,948
Iris, rhizomatous	129	13,693	103	8,625	973	231,822	817	118,610
Iris, bulbous	160	6,915,424	135	4,174,911	914	33,452,187	701	21,072,922
Other bulbs, rhizomes, and roots	156	1,631,653	137	889,459	982	11,191,812	739	5,472,684
Peony	112	53,878	101	24,909	849	1,299,805	668	608,289
Rose	117	22,487	90	16,491	792	173,933	667	127,488
Orchid	139	13,538	128	11,397	889	145,217	764	106,537
Ornamental	168	167,262	146	157,806	1,030	2,919,753	814	1,883,881
Herbaceous	125	88,553	107	76,296	909	4,565,286	710	2,824,146
Fruit trees and small fruits	20	2,721	19	2,015	97	10,244	62	4,045
Narcissus	251	38,955,266	218	42,799,132	407	109,423,669	218	42,799,132
Total		54,006,343		49,015,537		209,354,890		101,491,741

During the year 1,453 such permits were issued authorizing the entry of 54,006,343 plants and bulbs; a total of 49,015,537 plants and bulbs was imported under 1,259 permits as compared with a total of 6,021,508 plants and bulbs imported during 1926. Narcissi were placed under the restrictions of regulation 14 at the beginning of the calendar year 1926 and their importation was responsible for most of this increase. The narcissi imported during the fiscal year 1927 arrived, and the permits authorizing their entry were issued during the calendar year 1926, some of the permits being issued before and some after the end of the 1926 fiscal year, June 30, 1926. A summary of special permits issued during the entire period of the quarantine to date is given in Table 15. The number of varieties considered has now reached a total of 37,308 (an increase of 5,000 during the year), of which 35,389 have been approved for entry.

TABLE 15.—*Special-permit importations, yearly totals, 1920–1927*

Fiscal year	Permits issued		Permits imported	
	Number	*Quantity*	*Number*	*Quantity*
1920	311	10,752,844	171	3,484,195
1921	622	13,965,013	411	8,132,634
1922	750	9,573,199	518	3,344,026
1923	897	15,175,003	719	10,357,406
1924	1,107	15,381,621	862	12,561,306
1925	1,235	9,517,913	1,087	8,575,129
1926	1,445	80,982,954	1,200	6,021,508
1927	1,453	54,006,343	1,259	49,015,537
Total	7,820	209,354,890	6,227	101,491,741

Three classes of plants other than narcissus show heavy increases, while most of the remaining classes show heavy decreases in the quantities imported in 1927, as compared to importations in 1926, as is shown in Table 16.

TABLE 16.—*Special-permit material: Number of different varieties of plants requested and approved for fiscal years 1920–1927, and comparison of importations for fiscal years 1926 and 1927*

Class of plants	Number of varieties of plants requested and approved, 1920–1927			Comparison of 1926 and 1927 importations	
	Requested	Approved	Percentage approved	1926	1927
Gladiolus	1,427	1,310	91.80	1,880,054	848,761
Dahlia	2,583	2,445	94.66	2,216	5,735
Iris, rhizomatous	2,201	2,080	94.50	21,797	8,625
Iris, bulbous	483	483	100.00	2,453,408	4,174,911
Other bulbs, rhizomes and roots	2,472	2,428	98.22	948,883	889,459
Peony	1,712	1,470	85.86	108,743	24,909
Rose	3,403	3,043	89.42	28,556	16,491
Orchid	7,333	7,307	99.65	20,372	11,397
Ornamental	9,813	9,137	93.11	169,891	157,806
Herbaceous	4,685	4,507	96.20	386,462	76,296
Fruit trees and small fruits	263	250	95.06	1,126	2,015
Narcissus	933	929	99.57		42,799,132
Total	37,308	35,389	94.86	6,021,508	49,015,537

In addition to the tables mentioned there has been prepared a table (Table 17) showing the distribution of the imported special-permit material by States. In addition to the foregoing there were imported from Canada under regulation 15, quarantine 37, 413,259 bulbs, plants, trees, or cuttings, as compared to 128,336 during the fiscal year 1926.

TABLE 17.—*Distribution of special-permit material by States for fiscal years 1920–1927*

State	Gladiolus	Dahlia	Rhizomatous iris	Bulbous iris	Peony	Rose	Orchid	Ornamental, etc.	Narcissus	Total
Alabama	14,988	0	0	30,980	0	174	0	0	0	46,142
Arizona	4	14	0	0	0	9	14	2,275	0	2,316
Arkansas	0	0	0	18,000	0	0	0	0	0	18,000
California	1,816,620	4,413	26,403	10,047,924	2,168	21,734	29,832	1,910,381	4,700,811	18,560,286
Colorado	17,095	0	0	33,490	150	0	1,192	5,381	0	57,308
Connecticut	16,984	995	1,258	22,745	113	31,318	6	171,185	4,750	249,354
Delaware	2,000	0	22	700	16	0	327	5,238	5	8,308
District of Columbia	500	140	59	127	0	213	74	226	0	1,339
Florida	47,510	0	0	391,192	0	21	11	277,088	7,582,377	8,298,199
Georgia	9,210	360	181	128,485	0	0	0	2,988	2,251	143,475
Idaho	381	0	0	2,000	0	0	0	0	0	2,381
Illinois	3,233,385	85	13,239	881,390	43,968	9,737	545	218,301	36,900	4,437,550
Indiana	2,365,438	186	2,077	502,413	3,817	2,194	171	29,757	191	2,906,244
Iowa	110,478	0	0	10,000	23,143	0	0	14,062	250	157,933
Kansas	0	99	1,882	0	2,585	0	0	399	33	4,998
Kentucky	0	408	0	51,200	0	0	415	0	0	52,023
Louisiana	2,500	116	0	21,750	0	0	766	425	0	25,557
Maine	350	0	35	0	262	0	0	693	0	1,340
Maryland	23,057	312	128	275,575	19,780	500	378	8,745	128	328,603
Massachusetts	3,433,679	955	3,172	487,560	6,336	2,122	17,520	457,031	1,069	4,409,444
Michigan	12,278,974	3,395	3,106	495,822	78,128	290	530	522,562	1,381,975	14,764,782
Minnesota	82,177	49	1,005	0	7,418	160	519	35,237	0	126,565
Mississippi	6,500	0	9	49,776	0	0	0	27	0	56,312
Missouri	2,450	182	292	281,211	991	0	3,671	19,528	510	308,835
Montana	0	0	0	0	0	0	0	100	0	100
Nebraska	1,132	276	0	0	14	0	0	351	0	1,773
Nevada	0	0	0	0	0	0	0	0	0	0
New Hampshire	40,021	7	0	11,500	0	0	0	1,183	0	52,711
New Jersey	99,395	4,325	10,011	880,669	38,799	30,709	21,829	2,467,978	456,215	4,009,930
New Mexico	0	0	0	5,000	0	0	0	0	0	5,000
New York	1,825,963	3,681	28,179	1,803,478	184,796	15,074	18,324	2,710,796	6,104,561	12,694,852
North Carolina	3,975	82	0	667,622	0	0	0	739	235,315	907,733
North Dakota	21,915	0	0	0	7	1	0	0	0	21,923
Ohio	478,495	1,910	18,474	46,856	123,832	4,036	145	754,742	0	1,428,490
Oklahoma	510	0	0	14,000	0	0	0	198	0	14,708

TABLE 17.—*Distribution of special-permit material by States for fiscal years 1920–1927*—Continued

State	Gladiolus	Dahlia	Rhizomatous iris	Bulbous iris	Peony	Rose	Orchid	Ornamental, etc.	Narcissus	Total
Oregon	48,412	1,286	1,408	383,708	2,651	1,140	0	37,519	330,811	806,935
Pennsylvania	355,354	1,390	2,488	152,443	51,446	4,286	9,085	251,435	181,000	1,008,927
Rhode Island	721	1,053	1,557	86,190	5,209	429	157	25,269	130,000	250,585
South Carolina	0	0	0	30,000	0	0	0	3	8,569,500	8,599,503
South Dakota	472	0	11	0	2,426	1,807	0	551	0	5,267
Tennessee	0	590	361	178,396	232	87	0	3,417	733,296	916,379
Texas	2,000	1	50	663,031	0	290	6	28,521	4,465,970	5,159,869
Utah	0	0	0	17,000	0	0	0	4,747	11,100	32,847
Vermont	6,771	0	36	8,010	2,359	0	0	1,597	0	18,773
Virginia	16,000	53	2	1,199,754	1,340	0	6	42,666	3,206,482	4,466,303
Washington	26,084	319	2,697	1,080,975	3,515	637	0	122,655	4,478,032	5,714,914
West Virginia	0	0	0	4,000	0	0	0	36	0	4,036
Wisconsin	55,559	266	468	107,950	2,788	520	1,014	48,724	185,600	402,889
Wyoming	0		0	0	0	0	0	0	0	0
Total	26,447,059	26,948	118,610	21,072,922	608,289	127,488	106,537	10,184,756	42,799,132	101,491,741

In addition to the foregoing, there were imported from Canada, under regulation 15, quarantine 37, in excess of 400,000 plants.

IMPORTATIONS OF COTTON AND COTTON PRODUCTS

Tables 18 to 21 indicate, respectively, the importations of cotton, cotton waste, bagging, cottonseed, seed cotton, and cottonseed products during the year. The actual number of bales of cotton, cotton waste, and bagging is indicated, but inasmuch as bales vary in size, they are referred to as running bales.

In addition to the commercial importations indicated below, the board supervised the entry and disinfection of 1,070 cotton samples, including 7 packages of linters, imported by freight or express, 38 cotton-waste samples imported by freight or express, and 13,926 cotton and cotton-waste samples and linters imported by parcel post.

TABLE 18.—*Importation of ginned cotton, by country of growth and port of entry, 1926–27*

[Running bales]

Country	Boston	Buffalo	Calexico	Detroit	El Paso	Galveston	Malone	New Orleans	Newport	New York	Niagara Falls
Algeria	10										
Anglo-Egyptian Sudan	171										
Brazil										37	
British West Indies										1,106	
Chile										3	
China	1,988									3,296	
Cuba										39	
Dominican Republic										233	
Dutch East Indies	1,250									2,075	
Dutch Guiana										16	
Egypt	150,626									8,262	
Haiti										1,023	
India	8,752									14,127	
Japan										50	
Mexico			90,860		5,012					66,941	
Peru	1,299									98,790	
Porto Rico										2,971	
Salvador										12	
Uganda	36										
United States (returned)	965	39		50		292	10	22	2,293	27	103
Unknown	312										
Total	165,409	39	90,860	50	5,012	292	10	22	2,293	199,008	103

TABLE 18.—*Importation of ginned cotton, by country of growth and port of entry, 1926–27*—Continued

Country	Norfolk	Philadelphia	Portland	Presidio	Providence	Richford	Rouses Point	Saint Albans	San Francisco	Seattle	Vanceboro	Total
Algeria												10
Anglo-Egyptian Soudan												171
Brazil												37
British West Indies												1,106
Chile												3
China			50						20,176	6,988		32,498
Cuba												39
Dominican Republic												233
Dutch East Indies												3,325
Dutch Guiana												16
Egypt								[1] 172				159,060
Haiti												1,023
India									400			23,279
Japan												50
Mexico				150								162,963
Peru												100,089
Porto Rico												2,971
Salvador												12
Uganda												36
United States (returned)	3	3			14	189	121	142			789	5,062
Unknown												312
Total	3	3	50	150	14	189	121	314	20,576	6,988	789	[2] 492,295

[1] Previously entered, disinfected, and exported.
[2] Includes 6,938 bales of linters.

TABLE 19.—*Importation of cotton waste, by country of origin and port of entry, 1926–27*

[Running bales]

Country	Baltimore	Buffalo	Boston	Charleston	Detroit	El Paso	Galveston	Los Angeles	New Orleans	New port	New York
Austria											388
Belgium			35				144		128		1,114
Brazil			30								
Canada		38	1,067		32					431	1
Ceylon											214
China											145
Cuba											8
England			4,272	104					75		975
France			417						10		1,222
Germany			352	438			99				2,034
Holland			2,189				137	22			361
India	100		50								4,002
Italy			75						22		1,304
Japan			401								1,497
Mexico						89					558
Scotland	9										2
Spain			86								128
Switzerland			1,545								232
United States (returned)			16								
Wales											131
Total	109	38	10,535	542	32	89	380	22	235	431	14,316

TABLE 19.—*Importation of cotton waste, by country of origin and port of entry, 1926–27*—Continued

Country	Niagara Falls	Philadelphia	Port Huron	Portland	Richford	Rouses Point	Saint Albans	San Francisco	Savannah	Seattle	Total
Austria											388
Belgium		213									1,634
Brazil											30
Canada	100	5	210		7	11	757				2,659
Ceylon		166									380
China		70						407		241	863
Cuba											8
England		1,442							30		6,898
France		575									2,224
Germany		1,610									4,533
Holland		533									3,242
India		1,900									6,052
Italy		694									2,095
Japan		550		1				2,638		4,426	9,513
Mexico											647
Scotland		97									108
Spain											214
Switzerland		363									2,140
United States (returned)							3				19
Wales											131
Total	100	8,218	210	1	7	11	760	3,045	30	4,667	43,778

TABLE 20.—*Importation of bagging, by country of origin and port of entry, 1926–27*

[Running bales]

Country	Baltimore	Boston	Buffalo	Charleston	Detroit	Galveston	Houston	Los Angeles	Mobile	New Orleans
Austria				148						609
Belgium	5,853	3,075		387			49			3,243
Canada	810	107	45		1,977					1,319
Cuba										1,140
Denmark	1,000								400	2,902
England	1,742	2,634		657		1,296	3,081			5,269
Finland	427									
France	2,688	656		27			860			7,126
Germany	2,135	760		459						5,716
Holland	939	2,090		60		740	2,420		200	9,383
Italy	55	609					1,431			1,093
Japan								60		
Norway		55								
Scotland	212	1,067								19
Spain										874
Switzerland		855		336						
Wales	111									
Total	15,972	11,908	45	2,074	1,977	2,036	7,841	60	600	38,693

TABLE 20.—*Importation of bagging by country of origin and port of entry, 1926–27*—Continued

Country	New York	Newport	Norfolk	Philadelphia	Port Huron	Rouses Point	San Francisco	Savannah	Seattle	Total
Algeria	1,207			87						1,294
Austria	749		3,060				385	1,032		5,983
Belgium	3,770		3,163	526			22	1,496		21,584
Canada	7,894	42		276	4,379	53				16,902
China	4						886			890
Cuba	133									1,273
Denmark	10,071			144						14,517
Egypt	1,080			58						1,138
England	6,043		14,559	4,321				3,083		42,685
Finland										427
France	6,425		957	1,270			47	194		20,250
Germany	6,988		2,786	62			171	1,714		20,791
Greece	130									130
Holland	5,863		5,687	1,211				1,027		29,620
India	135			281						416
Ireland	5,947									5,947
Italy	4,153			246						7,587
Japan	752			200			3,949		7,304	12,265
Malta	12									12
Mexico	242									242
Morocco	51									51
Norway	723									778
Scotland	2,109		141	55				49		3,652
Spain	2,079			116						3,069
Switzerland	339		531							2,061
Wales										111
Total	66,899	42	30,884	8,853	4,379	53	5,460	8,595	7,304	213,675

TABLE 21.—*Importation, in tons, of cottonseed, seed cotton, and cottonseed hulls, cake, and meal, 1926–27*

Port	Cottonseed	Seed cotton	Cottonseed hulls	Cottonseed cake	Cottonseed meal	Port	Cottonseed	Seed cotton	Cottonseed hulls	Cottonseed cake	Cottonseed meal
Boston				3	428	Laredo				814	
Calexico	15,788		579			Yuma		33			
Eagle Pass				4,760		Total	[1]15,788	[1]33	[1]579	5,577	428

[1] Entry of cottonseed and seed cotton grown in the Imperial Valley, Lower California, Mexico, is allowed under permit.

IMPORTATIONS OF FRUITS AND VEGETABLES

Tables 22 and 23 indicate, respectively, the fruits and vegetables imported under permit and inspection during the fiscal year by countries of origin and by ports of entry.

TABLE 22.—*Fruits and vegetables imported during year ended June 30, 1927, by countries of origin*

[Quarantine 56 unless otherwise designated]

Kind	Country and quantity	Total
Apple.....pounds..	Germany, 209; Norway, 45; Sweden, 80	334
Artichoke.....do....	Mexico, 30	30
Asparagus.....do....	Argentina, 15,200	15,200
Avocado.....do....	Colombia (Santa Marta district), 30,202; Cuba, 5,261,367; Dominica, British West Indies, 22,944; Dominican Republic, 3,050; Jamaica, 4,070; Mexico (seeds removed), 54,214; St. Lucia, British West Indies, 400.	5,376,247
Ayale (Crescentia sp.)..do....	Mexico, 593	593
Banana.....bunches..	Colombia, 2,286,506; Costa Rica, 5,124,799; Cuba, 3,135,238; Dominican Republic, 2; Guadeloupe, Fench West Indies, 204; Guatemala, 6,633,004; Honduras, 15,131,821; British Honduras, 175,800; Jamaica, 13,807,440; Mexico, 6,484,692; Nicaragua, 1,800,614; Panama (including Canal Zone), 4,817,817; St. Lucia, British West Indies, 38,693.	59,436,630
Bean (green):		
Lima.....pounds..	Cuba, 1,033,241; Mexico, 11,023	1,044,264
String.....do....	Cuba, 40,626; Mexico, 427,986	468,612
Beet.....do....	Bermuda, 414,471; Holland, 9,931; Mexico, 219,761	644,163
Berry (Rubus).....do....	Norway, 600	600
Cabbage.....do....	Holland, 3,008,548; Mexico, 41,504	3,050,052
Cacao bean pod.....do....	Costa Rica, 2,227; Jamaica, 86; Venezuela, 45	2,358
Carrot.....do....	Bermuda, 1,887,529; Holland, 50,000; Mexico, 470,747	2,408,276
Cassava.....do....	China, 1,600; Cuba, 246,132; Dominican Republic, 7,944	255,676
Cauliflower.....do....	Cuba, 250; Mexico, 1,888	2,138
Celery.....do....	Bermuda, 3,705,289; Mexico, 989	3,706,278
Chayote.....do....	Cuba, 550; Dominican Republic, 7,662; Mexico, 3,712	11,924
Cherry:		
Fresh.....do....	Argentina, 5,690	5,690
Dried (sour).....do....	Italy, 1,371,307; Yugoslavia, 81,065	1,452,372
Cipollino.....do....	Italy, 2,054,342	2,054,342
Clover top.....do....	Mexico, 1,042	1,042
Citrus medica.....do....	Greece, 2,293; Italy, 422; Palestine, 22,297; Syria, 220	25,232
Crosnes.....do....	Belgium, 808	808
Cucumber.....do....	Bermuda, 85; Cuba, 1,014,886; Mexico, 310,141	1,325,112
Dasheen (includes colocasia, caladium, inhame, malanga, and taro), pounds.	Azores, 264,357; China, 728,520; Dominica, British West Indies, 310; Dominican Republic, 250,070; Japan, 334,701; Mexico, 14,200; St. Lucia, British West Indies, 9,210.	1,601,368
Eggplant.....pounds..	Cuba, 6,085,183; Dominican Republic, 180; Mexico, 495,398; Virgin Islands, 6,730.	6,587,491
Endive.....do....	Belgium, 1,651,862; England, 27,818; Holland, 700	1,680,380
Fennel.....do....	Bermuda, 924	924
Garlic.....do....	Azores, 2,336; Chile, 437,412; China, 4,160; Egypt, 33,510; Italy, 419,906; Mexico, 323,603; Spain, 7,512.	1,228,439
Ginger (crude).....do....	China, 438,782; Cuba, 1,622; Dominican Republic, 4,262; Jamaica, 350; Japan, 1,610; Virgin Islands, 40.	446,666
Grapefruit.....do....	Cuba, 16,524,177; Jamaica, 22,205	16,546,382
Grape:		
Fresh (not hot-house), pounds.	Argentina, 1,693,359; Chile, 500,363; Mexico, 1,727	2,195,449
Hothouse.....pounds..	Belgium, 324,148; England, 300	324,448
Processed.....do....	Italy, 6,870	6,870
Waste.....do....	Italy, 5,547	5,547
Horse-radish.....do....	Germany, 766,803	766,803
Husk tomato.....do....	Mexico, 47,583	47,583
Jicame.....do....	Mexico, 33,881	33,881
Kale.....do....	Bermuda, 907,629	907,629
Kohl-rabi.....do....	Bermuda, 590; Mexico, 81	671
Kudzu.....do....	China, 214,731	214,731
Lemon.....crates..	Algeria, 100; Argentina, 15; Egypt, 1; Italy, 567,388; Mexico, 35.	567,539
Lettuce.....pounds..	Bermuda, 36,368; Mexico, 229,187	265,555
Lily bulb (edible).....do....	China, 18,477; Japan, 400	18,877
Lime (sour).....do....	Costa Rica, 10,854; Cuba, 850; Dominica, British West Indies, 3,063,415; Dominican Republic, 75; Haiti, 840; Italy, 79,500; Jamaica, 289,007; Mexico, 1,905,426; St. Lucia, British West Indies, 145,430; Trinidad, British West Indies, 11,550.	5,506,947
Melon.....do....	Argentina, 755,228: Chile, 434,939; Italy, 24,186; Mexico, 1,448,172; Spain, 168,653.	2,831,178
Mint.....do....	Bermuda, 360; Mexico, 512	872
Mustard.....do....	Bermuda, 1,029; Mexico, 47,837	48,866
Nectarine.....do....	Belgium, 123; Chile, 17,976	18,099

TABLE 22.—*Fruits and vegetables imported during year ended June 30, 1927, by countries of origin*—Continued

Kind	Country and quantity	Total
Nuts (in the shell): [1]		
Acorn ..... pounds	Greece, 1,188,844; Italy, 893,397; Turkey, 4,192,050	6,274,291
Chestnut ..... do	Corsica, 1,667; France, 70,625; Italy, 22,977,844; Spain, 1,558,086.	24,608,222
Filbert ..... do	Greece, 6,972; Italy, 5,188,137; Russia, 100,310; Spain, 853; Turkey, 27,033.	5,323,305
Walnut ..... do	France, 1,804,759; Germany, 87,840; Italy, 11,791,951; Poland, 11,020; Rumania, 2,054,837; Russia, 8,782; Turkey, 225,831; Yugoslavia, 1,629.	15,996,649
Okra [2] ..... do	Cuba, 639,590; Dominican Republic, 20	639,610
Onion ..... do	Antigua, British West Indies, 49,600; Australia, 189,698; Azores, 4,101; Bermuda, 501,511; Chile, 4,575,124; Cuba, 18,755; Denmark, 220; Dominica, British West Indies, 3,770; Egypt, 56,295,830; England, 196; Germany, 67,132; Holland, 1,047,513; Italy, 2,163,780; Japan, 119,048; Mexico, 461,771; Montserrat, British West Indies, 181,100; Rumania, 12,350; Spain, 63,092,924; Virgin Islands, 214,240.	128,998,663
Orange:		
Under quarantine 56, pounds.	Cuba, 59,400; Dominica, British West Indies, 60; Dominican Republic, 9,213; Jamaica, 34,890.	103,563
Mandarin (quarantine 28), pounds.	Japan, 1,069,416	1,069,416
Pachyrhizus ..... pounds	China, 47,900	47,900
Parsley ..... do	Bermuda, 1,020,540; Mexico, 24,555	1,045,095
Parsnip ..... do	Holland, 310,915; Mexico, 110	311,025
Pea ..... do	Cuba, 820; Mexico, 14,277,129	14,277,949
Peach ..... do	Argentina, 136,797; Belgium, 972; Chile, 59,002	196,771
Pear ..... do	Argentina, 35,980; Sweden, 15	35,995
Pepper ..... do	Bahamas, 40; Cuba, 8,619,977; Dominican Republic, 60; Haiti, 1,060; Jamaica, 3,950; Mexico, 8,968,473; Virgin Islands, 14,570.	17,608,130
Pigweed ..... do	Mexico, 295	295
Pineapple ..... crates	Antigua, British West Indies, 2; Azores, 48; Costa Rica, 18,130; Cuba, 1,195,741; Dominican Republic, 9; Haiti, 1,767; Honduras, 52; Mexico, 28,899; Panama (including Canal Zone), 431; Union of South Africa, 20.	1,245,099
Plantain ..... bunches	Cuba, 329,520; Dominican Republic, 1,539; Honduras, 97,908; British Honduras, 36,525; Mexico, 39; Panama, 36; St. Lucia, British West Indies, 5.	465,572
Plum ..... pounds	Argentina, 32,372; Chile, 952	33,324
Potato:		
Under quarantine 56, pounds.	Bermuda, 5,815,466	5,815,466
Under potato regulations (order of Dec. 22, 1913), pounds.	Cuba, 4,439,810; Mexico, 1,805,846	6,245,656
Prickly pear ..... pounds	Mexico, 3,095	3,095
Pumpkin ..... do	Cuba, 55,664; Dominican Republic, 46,012; Jamaica, 1,250; Mexico, 10,419.	113,345
Purslane ..... do	Mexico, 31	31
Quince ..... do	Argentina, 71	71
Radish ..... do	Mexico, 45,310	45,310
Roselle ..... do	Mexico, 1,310	1,310
Sea onion ..... do	Denmark, 690	690
Sorrel ..... do	Bermuda, 1,932	1,932
Spinach ..... do	Bermuda, 120; Mexico, 99,996	100,116
Squash ..... do	Cuba, 436,405; Mexico, 85,806	522,211
Strawberry ..... do	Mexico, 492	492
Tamarind bean pod ..... do	Antigua, British West Indies, 20,041; Barbados, British West Indies, 380; Dominican Republic, 964; Dutch Guiana, 95; Mexico, 17.	21,497
Tangerine ..... do	Argentina, 15,692; Cuba, 210	15,902
Tomato ..... do	Argentina, 13,228; Bahamas, 5,804,396; Cuba, 12,884,437; Dominican Republic, 30; England, 50; Haiti, 6,098; Mexico, 105,701,086; Virgin Islands, 3,800.	124,413,125
Turnip [3] ..... do	Bermuda, 23,671; Holland, 208,732; Mexico 125,807	358,210
Vaccinium (cranberry, etc.), pounds.	Newfoundland, 222,483; Norway, 660; Poland, 28,868; Sweden, 110.	252,121
Water chestnut ..... pounds	China, 1,547,071; Japan, 1,400	1,548,471
Water cress ..... do	Mexico, 5,599	5,599
Water-lily root ..... do	China, 71,522; Japan, 2,000	73,522
Watermelon ..... do	Bahamas, 1,045; Chile, 2,458; Cuba, 24,000; Jamaica, 290; Mexico, 581,868; Peru ,1,221.	610,882

[1] The permit requirements for the entry of walnuts and filberts from Europe were removed June 1, 1927.
[2] Permits authorizing entry of okra from the West Indies, except Cuba, were revoked November 20, 1926, on account of the pink bollworm.
[3] Permits authorizing entry of turnips from Holland were revoked April 8, 1927, on account of the turnip gall weevil.

TABLE 23.—*Fruits and vegetables imported during year ended June 30, 1927, by ports of entry*

[Quarantine 56 unless otherwise designated]

Kind	Port and quantity	Total
Apple.....pounds	New York, 334	334
Artichoke.....do	Laredo, 30	30
Asparagus.....do	New York, 15,200	15,200
Avocado.....do	Brownsville (seeds removed), 384; Eagle Pass (seeds removed), 2,328; El Paso (seeds removed), 5,501; Key West, 893,992; Laredo (seeds removed), 45,988; New Orleans, 1,657,057; New York, 1,049,984; Nogales (seeds removed), 13; Tampa, 1,721,000.	5,376,247
Ayale (Crescentia sp.)..do	Nogales, 593	593
Banana.....bunches	Baltimore, 2,662,029; Boston, 3,651,692; Charleston, 657,409; Eagle Pass, 2,004; El Paso, 421,549; Galveston, 1,005,500; Jacksonville, 15,700; Key West, 16,470; Laredo, 9,801; Los Angeles, 524,672; Miami, 268,401; Mobile, 3,612,080; New Orleans, 23,497,075; New York, 17,521,442; Nogales, 95,508; Philadelphia, 5,012,688; San Francisco, 26,565; Tampa, 436,045.	59,436,630
Bean (green):		
Lima.....pounds	Laredo, 704; New York, 1,033,241; Nogales, 9,369; San Ysidro, 950.	1,044,264
String.....do	Brownsville, 237,032; Calexico, 273; Douglas, 5,109; Eagle Pass, 1,445; El Paso, 49,541; Laredo, 56,667; New York, 40,626; Nogales, 33,587; San Ysidro, 44,332.	468,612
Beet.....do	Douglas, 14,375; Eagle Pass, 2,897; El Paso, 189,849; New York, 424,402; Nogales, 12,637; San Ysidro, 3.	644,163
Berry (Rubus).....do	New York, 600	600
Cabbage.....do	Calexico, 2,392; Douglas, 13,031; Eagle Pass, 14; El Paso, 5,512; Laredo, 2,365; New York, 3,008,548; Nogales, 16,208; San Ysidro, 1,982.	3,050,052
Cacao bean pod.....do	New York, 2,358	2,358
Carrot.....do	Calexico, 345; Douglas, 24,738; Eagle Pass, 1,622; El Paso, 428,539; New York, 1,937,529; Nogales, 15,503.	2,408,276
Cassava.....do	Chicago, 1,100; Key West, 28,825; New York, 197,181; Seattle, 500; Tampa, 28,070	255,676
Cauliflower.....do	Calexico, 20; Douglas, 708; Eagle Pass, 32; New York, 250; Nogales, 1,122; San Ysidro, 6.	2,138
Celery.....do	Douglas, 875; New York, 3,705,289; Nogales, 114	3,706,278
Chayote.....do	El Paso, 3,260; Laredo, 450; New Orleans, 405; New York, 7,807; Nogales, 2.	11,924
Cherry:		
Fresh.....do	New York, 5,690	5,690
Dried (sour).....do	Boston, 121,934; New York, 1,278,741; Philadelphia, 51,697	1,452,372
Cipollino.....do	Boston, 120,337; Los Angeles, 22,000; New York, 1,912,005	2,054,342
Clover top.....do	Douglas, 1,042	1,042
Citrus medica.....do	Baltimore, 4,650; New York, 20,582	25,232
Crosnes.....do	New York, 808	808
Cucumber.....do	Calexico, 1,001; Douglas, 2,952; Eagle Pass, 152; El Paso, 175; Key West, 1,915; New Orleans, 9,860; New York, 1,003,156; Nogales, 303,694; San Ysidro, 2,167; Tampa, 40.	1,325,112
Dasheen (includes colocasia, caladium, inhame, malanga, and taro), pounds.	Boston, 17,730; Calexico, 14,200; Chicago, 4,800; Los Angeles, 20,600; New York, 373,140; Portland, 5,300; Providence, 264,357; San Francisco, 681,033; Seattle, 218,958; Tacoma, 1,250.	1,601,368
Eggplant.....pounds	Calexico, 340; Douglas, 1,221; Key West, 27,660; Laredo, 18,695; Los Angeles, 30,321; New Orleans, 936,244; New York, 5,119,249; Nogales, 443,961; Tampa, 9,800.	6,587,491
Endive.....do	New York, 1,680,380	1,680,380
Fennel.....do	New York, 924	924
Garlic.....do	Boston, 13,200; Calexico, 832; Douglas, 4,570; Eagle Pass, 627; El Paso, 13,809; Laredo, 275,517; New Orleans, 40,938; New York, 867,899; Nogales, 4,551; Providence, 2,336; San Francisco, 4,160.	1,228,439
Ginger (crude).....do	Boston, 4,200; Chicago, 2,800; Los Angeles, 8,200; New York, 65,767; San Francisco, 287,667; Seattle, 78,032.	446,666
Grapefruit.....do	Boston, 12,460; Chicago, 2,487,100; Cincinnati, 2,193,529; New York, 10,024,518; Philadelphia, 15; St. Louis, 1,828,760.	16,546,382
Grape:		
Fresh (not hothouse), pounds.	Eagle Pass, 1,566; Laredo, 138; New York, 2,193,722; Nogales, 23.	2,195,449
Hothouse.....pounds	New York, 324,448	324,448
Processed.....do	New York, 6,870	6,870
Waste.....do	New York, 5,547	5,547
Horse-radish.....do	New York, 757,412; Philadelphia, 9,391	766,803
Husk tomato.....do	Brownsville, 545; El Paso, 47,038	47,583
Jicame.....do	El Paso, 33,531; Nogales, 350	33,881
Kale.....do	New York, 907,629	907,629
Kohl-rabi.....do	Calexico, 45; Douglas, 36; New York, 590	671
Kudzu.....do	Boston, 3,526; Los Angeles, 12,700; New York, 95,400; Portland, 200; San Francisco, 64,339; Seattle, 38,566.	214,731

TABLE 23.—*Fruits and vegetables imported during year ended June 30, 1927, by ports of entry*—Continued

Kind	Port and quantity	Total
Lemon ..... crates	Boston, 1,552; El Paso, 2; New Orleans, 95,720; New York, 470,230; Nogales, 30; Philadelphia, 2; San Ysidro, 3.	567, 539
Lettuce ..... pounds	Douglas, 24,975; Eagle Pass, 5,593; El Paso, 19,468; New York, 36,368; Nogales, 179,149; San Ysidro, 2.	265, 555
Lily bulb (edible) ..... do	Boston, 2,754; Chicago, 300; New York, 3,100; San Francisco, 5,898; Seattle, 6,825.	18, 877
Lime (sour) ..... do	Boston, 8,611; Brownsville, 129; Charleston, 7,650; Eagle Pass, 297,026; El Paso, 29,467; Laredo, 1,209,518; Los Angeles, 356,517; New Orleans, 175,438; New York, 3,403,039; Nogales, 5,433; Philadelphia, 3; San Francisco, 13,666; Tampa, 450.	5, 506, 947
Melon ..... do	Boston, 500; Calexico, 199,157; Douglas, 657; Eagle Pass, 10; Laredo, 470; New York, 1,382,506; Nogales, 1,247,878.	2, 831, 178
Mint ..... do	Calexico, 168; Douglas, 114; Eagle Pass, 8; El Paso, 222; New York 360.	872
Mustard ..... do	Calexico, 7,450; Douglas, 11,524; El Paso, 13,700; New York, 1,029; Nogales, 15,163.	48, 866
Nectarine ..... do	New York, 18,099	18, 099
Nuts (in the shell): [1]		
Acorn ..... do	New York, 6,274,291	6, 274, 291
Chestnut ..... do	Boston, 1,328,252; New York, 23,264,903; Philadelphia, 2,067; San Francisco, 13,000.	24, 608, 222
Filbert ..... do	Baltimore, 30,990; Boston, 466,909; New York, 4,501,525; Philadelphia, 114,391; San Francisco, 209,490.	5, 323, 305
Walnut ..... do	Boston, 1,204,254; New York, 14,771,515; Philadelphia, 10,880; San Francisco, 10,000.	15, 996, 649
Okra [2] ..... do	Key West, 16,850; Miami, 450; New Orleans, 323,231; New York, 294,624; Tampa, 4,455.	639, 610
Onion ..... do	Boston, 18,077,233; Calexico, 1,704; Douglas, 48,364; Eagle Pass, 1,411; El Paso, 316,204; Laredo, 51,440; New Orleans, 8,818; New York, 109,805,148; Nogales, 42,531; Philadelphia, 109,116; Portland, 223,830; Providence, 4,101; San Francisco, 55,487; San Ysidro, 17; Seattle, 253,259.	128, 998, 663
Orange:		
Under quarantine 56, pounds.	Boston, 2,520; Chicago, 45,220; New York, 55,815; Philadelphia, 8.	103, 563
Mandarin (quarantine 28), pounds.	Seattle, 959,616; Tacoma, 109,800	1, 069, 416
Pachyrhizus ..... pounds	San Francisco, 47,900	47, 900
Parsley ..... do	Douglas, 1,636; Eagle Pass, 99; El Paso, 22,810; New York, 1,020,540; Nogales, 10.	1, 045, 095
Parsnip ..... do	El Paso, 110; New York, 310,915	311, 025
Pea ..... do	Calexico, 2,521; Douglas, 1,709; Eagle Pass, 291; El Paso, 656; Laredo, 1,030; Los Angeles, 5,100; New York, 820; Nogales, 14,165,500; San Diego, 46,030; San Ysidro, 54,292.	14, 277, 949
Peach ..... do	New York, 196,771	196, 771
Pear ..... do	New York, 35,995	35, 995
Pepper ..... do	Brownsville, 20,089; Calexico, 844; Del Rio, 8,003; Douglas, 22,945; Eagle Pass, 53,804; El Paso, 496,726; Key West, 90,214; Laredo, 241,212; Los Angeles, 10,442; Miami, 810; New Orleans, 375,594; New York, 8,162,074; Nogales, 8,114,-248; San Ysidro, 160; Tampa, 10,965.	17, 608, 130
Pigweed ..... do	Douglas, 295	295
Pineapple ..... crates	Boston, 3,659; Douglas, 41; El Paso, 27,915; Key West, 932,314; Laredo, 936; Miami, 250; Mobile, 200; New Orleans, 55,039; New York, 209,379; Nogales, 7; Providence, 48; San Francisco, 85; Tampa, 15,226.	1, 245, 099
Plantain ..... bunches	Boston, 500; Key West, 135,891; Miami, 21,047; New Orleans, 37,193; New York, 47,110; Nogales, 22; Tampa, 223,809.	465, 572
Plum ..... pounds	New York, 33,324	33, 324
Potato:		
Under quarantine 56, pounds.	New York, 5,815,466	5, 815, 466
Under potato regulations (order of Dec. 22, 1913), pounds.	Calexico, 60; Douglas, 1,663,358; El Paso, 17,394; Key West, 264,790; New Orleans, 539,510; New York, 3,635,510; Nogales, 125,034.	6, 245, 656
Prickly pear ..... pounds	Eagle Pass, 70; El Paso, 1,440; Laredo, 1,585	3, 095
Pumpkin ..... do	Calexico, 310; Douglas, 2,299; Eagle Pass, 4,236; Key West, 27,402; Laredo, 3,540; New York, 63,042; Nogales, 34; Tampa, 12,482.	113, 345
Purslane ..... do	Douglas, 31	31
Quince ..... do	New York, 71	71
Radish ..... do	Calexico, 346; Douglas, 8,924; Eagle Pass, 1,136; El Paso, 24,719; Nogales, 10,184; San Ysidro, 1.	45, 310
Roselle ..... do	Nogales, 1,310	1, 310
Sea onion ..... do	New York, 690	690
Sorrel ..... do	New York, 1,932	1, 932
Spinach ..... do	Calexico, 1,498; Douglas, 21,547; Eagle Pass, 138; El Paso, 56,318; New York, 120; Nogales, 20,494; San Ysidro, 1.	100, 116

[1] The permit requirements for the entry of walnuts and filberts from Europe were removed June 1, 1927

[2] Permits authorizing entry of okra from the West Indies, except Cuba, were revoked November 20, 1926, on account of the pink bollworm.

TABLE 23.—*Fruits and vegetables imported during year ended June 30, 1927, by ports of entry*—Continued

Kind	Port and quantity	Total
Squash.....do....	Brownsville, 210; Calexico, 1,445; Douglas, 9,394; El Paso, 38,111; Key West, 80; Los Angeles, 180; Miami, 1,230; New Orleans, 8,800; New York, 426,295; Nogales, 33,001; San Diego, 1,340; San Ysidro, 2,125.	522,211
Strawberry.....do....	Laredo, 492	492
Tamarind bean pod.....do....	Eagle Pass, 2; New York, 21,480; Nogales, 15	21,497
Tangerine.....do....	New York, 15,902	15,902
Tomato.....do....	Brownsville, 33,796; Calexico, 44,118; Del Rio, 3,771; Douglas, 23,823; Eagle Pass, 60,994; El Paso, 169,919; Galveston, 20,000; Key West, 501,898; Laredo, 904,900; Los Angeles, 2,953,026; Miami, 385,553; New Orleans, 2,172,247; New York, 15,805,354; Nogales, 99,684,440; San Diego, 397,376; San Francisco, 1,167,860; San Ysidro, 61,515; Tampa, 22,535.	124,413,125
Turnip[3].....do....	Calexico, 295; Douglas, 14,174; Eagle Pass, 844; El Paso, 98,207; New York, 232,403; Nogales, 12,285; San Ysidro, 2.	358,210
Vaccinium (cranberry, etc.), pounds.	Boston, 21,200; New York, 230,811; San Francisco, 110	252,121
Water chestnut.....do....	Boston, 30,525; Chicago, 35,000; Los Angeles, 35,660; New York, 295,100; Portland, 400; San Francisco, 612,724; Seattle, 539,062.	1,548,471
Water cress.....do....	Douglas, 3,440; Eagle Pass, 7; Nogales, 2,151; San Ysidro, 1	5,599
Water-lily root.....do....	Boston, 1,480; Chicago, 2,000; Los Angeles, 300; New York, 2,360; San Francisco, 41,964; Seattle, 25,418.	73,522
Watermelon.....do....	Brownsville, 64,804; Calexico, 89,700; Douglas, 1,169; Eagle Pass, 70; El Paso, 5,367; Key West, 24,000; New York, 5,014; Nogales, 420,758.	610,882

[3] Permits authorizing entry of turnips from Holland were revoked April 8, 1927, on account of the turnip gall weevil.

TABLE 24.—*Importations of brooms and broomcorn, by country of origin and port of entry, 1926–27*

Country	Boston		New York, brooms (cases and bundles)	Total	
	Brooms (cases and bundles)	Broomcorn (bales)		Brooms (cases and bundles)	Broomcorn (bales)
Canada	1			1	
Germany			1	1	
Hungary	1	684	2	3	684
Italy		381	123	123	381
Rumania			8	8	
Total	2	1,065	134	136	1,065

In addition to the regulated imports for consumption entry recorded in the foregoing tables, the board supervised the entry under permit, for immediate exportation or immediate transportation and exportation in bond, of great quantities of plants and plant products. Among some of the principal items may be mentioned 35,585½ pounds of tree seed, 540,675 fruit and rose stocks, 2,047,300 convallaria pips, 76,270 pounds of potatoes, 24,557,766 pounds of onions, 6,603,555 crates of grapefruit, and 10,834,549 pounds of tomatoes.

ENFORCEMENT OF DOMESTIC-PLANT QUARANTINES

The board is now enforcing, either directly or in cooperation with the Bureau of Entomology or the Bureau of Plant Industry, 19 domestic-plant quarantines concerning on the one hand interstate movement, and on the other hand movement between Hawaii or Porto Rico and the mainland.

The Hawaiian and Porto Rican quarantines are in a sense analogous to the foreign quarantines and entail like

methods of enforcement. The domestic quarantines which affect movement of plants and plant products between States for the purpose of preventing spread of new pests vary as to the efficiency of control of such spread with the nature of the pest. Diseases with wind-borne spores, such as the white-pine blister rust, and active rapidly flying insects, such as the Japanese beetle, are spreading locally in spite of stringent restrictions on the movement of infested products. On the other hand, the dissemination of soil-borne diseases such as the potato wart, and comparatively sedentary insects such as the gipsy moth and the date scale, is being efficiently prevented by cooperative effort under the Federal and supplemental State quarantines. In the former class, regulatory measures are being directed primarily toward preventing the establishment of isolated outbreaks which would result from the carriage of pests for long distances in commerce. In this particular the European corn borer, cotton pink bollworm, Japanese beetle and blister rust quarantine measures have been markedly successful. The separate areas in which there exist infestations of the pests named, in most cases represent separate introductions from foreign countries prior to the American legislation on the subject.

To make quarantine protection effective, the board needs and to a large extent has secured the hearty cooperation of the transportation companies and the traveling public. Express and freight agents and postmasters refuse to accept articles offered for shipment in violation of regulations and constitute the most important link in the enforcement personnel. For the purpose of detecting and intercepting contraband material, road stations are maintained around the European corn borer, Japanese beetle, pink bollworm, and Thurberia weevil infested areas. Very material aid in the enforcement of all quarantines relating to the movement of certain classes of nursery stock is given by the inspection at destination, now required and enforced by most States. This applies particularly to the articles restricted in movement on account of the gipsy moth, the brown-tail moth, the satin moth, the blister rust, and black stem rust. It has been possible also to make some inspection of parcels and freight in transit at important junction or transfer points. Such inspections have resulted in the discovery of upwards of 300 violations, many of them by persons unaware of the restrictions and others through carelessness on the part of dealers. The road-station inspections have resulted in thousands of interceptions of contraband material, often infested with living pests.

Of the quarantines discussed in general terms above, those on account of the white-pine blister rust and the black-stem rust of small grains are enforced in cooperation with the Bureau of Plant Industry. The quarantines on account of the Mediterranean fruit fly and the melon fly in Hawaii and, on the mainland, the quarantines on account of the Japanese beetle, the European corn borer, and the gipsy and brown-tail moths are enforced in cooperation with the Bureau of Entomology. Detailed discussion as to the results of such quarantines cooperatively enforced with bureaus of the department is eliminated from this report inasmuch as these subjects will be considered in the reports of the bureaus concerned. Some discussion is, however, desirable and is given relative to quarantines which are enforced under appropriations assigned to the board. These include the quarantines on account of the pink bollworm of cotton, Thurberia weevil, and the date scale, with some discussion of the Mexican fruit worm, the latter representing a new and important pest entry into the United States.

STATUS OF PINK BOLLWORM CONTROL

WESTWARD EXTENSION INTO ARIZONA

The important new phase of the year in the pink bollworm situation was the determination of its westward extension, involving three counties in southwestern New Mexico and three counties in southeastern Arizona. The first finding of infestation was at San Simon, Ariz., on November 19, 1926, and the determination, which was at once undertaken, of what seems to be the full extent of this westward spread was completed about the end of December. Some 10,000 acres are involved, consisting of fairly small areas more or less widely separated by stretches of mountain and desert. The isolation of these cotton areas should make the elimination of the pest simple in comparison with the eradication work which was done years ago in Texas and Louisiana. The surveys which were made as to other cotton areas in Arizona, including the very important Salt River Valley area,

seemed to indicate that there had been no wider spread of this pest in that State.

This new development, coming after the completion of the work on the appropriation for 1928 and representing a new and serious emergency, led to a request for a deficiency appropriation of $50,000, and an item reduced to $35,000 to meet this need was included in the second deficiency bill of 1927 which failed to pass. The situation demanded immediate work looking to early eradication of this pest in these new areas, and, therefore, pending action on the deficiency item, funds were secured to institute such work by reduction and, in part, discontinuation of other very necessary pink bollworm work in New Mexico, Texas, and Louisiana. An intensive inspection was immediately undertaken with respect to the crop of 1926 in the invaded counties and so far as possible the infested fields were cleaned, following methods which had been successful in the similar work in eastern Texas and in Louisiana.

Owing to the lateness of the season when this work could be started and the early plowing by planters of the fields concerned, it was possible to complete this clean-up work only as to one county in Arizona, namely, Cochise, involving approximately 1,500 acres. It is proposed, therefore, to secure or adjust funds in such manner as to enable the clean-up of all the new areas of infestation in connection with the crop of 1927. In this work and in the necessary controls to prevent spread, Arizona and New Mexico gave full cooperation. Under an order from the State entomologist of Arizona, cottonseed which had not moved up to the time infestation was discovered was required to be sterilized, and was then sent to Tucson in approved cars for immediate crushing. As to other movement of seed, it was later determined that all such seed had been sent either to El Paso or Tucson for crushing, greatly minimizing any risk. Controls were also placed on the movement of cotton lint. Such controls were followed up and supplemented as to interstate movement of cotton products by Federal quarantine action. (See p. 29.)

Complete tracing records were made by the board of all seed movement from the infested areas since 1923. Fortunately, 93 per cent of the cottonseed produced had been shipped either to Tucson or El Paso for crushing. Scouting in the vicinity of the destination of all shipments which it was possible to trace, showed no indication of the pink bollworm.

This spread of the pink bollworm into western New Mexico and eastern Arizona very possibly resulted from the movement of laborers from Mexico with their personal baggage, including pillows, mattresses, etc., articles usually stuffed with seed cotton, and the latter often infested with the larvae of this pest, and therefore indicates the necessity of strengthening at strategic points the inspection of the movement by motor or otherwise of such labor—work which has been very greatly restricted on account of inadequate funds.

STATUS IN OLD AREAS OF INFESTATION

The old areas of infestation by the pink bollworm, involving areas in eastern New Mexico along the Rio Grande in Texas and in the Pecos Valley in Texas and New Mexico, in central and eastern Texas, and in Louisiana, present two very distinct problems, namely, (1) as to the eradication areas in central and eastern Texas and in Louisiana where the pest has apparently been successfully eliminated, and (2) as to the areas along the Rio Grande and Pecos Valleys in western Texas and in New Mexico where no intensive effort has been made to eradicate the pest, it being realized that in these areas the opportunity of reinvasion from Mexico would make any effort at eradication wasteful—certainly so as to areas in the Rio Grande Valley.

The eradication areas.—With respect to the areas where the pink bollworm has been eliminated, the scouting of the year developed no evidence of any renewal of infestation and, in fact, no infestation has been found in any of these areas since 1921. It is perhaps worthy of note that this eradication over wide areas in eastern Texas and in Louisiana, together with the control of this pest in the western areas, has been effected by an expenditure of funds representing less than 0.02 per cent of the value of the crop for the period involved—certainly an insurance rate which can be well afforded. On the other hand, it would certainly seem to be a fair inference, in view of the wide foothold of the pink bollworm in the States mentioned, that except for these expenditures and the thoroughness of the eradication effort, this pest would certainly have now been widely spread throughout the Cotton Belt.

The infested areas.—The areas now known to be more or less infested by the pink bollworm include practically all cotton plantings in Texas and New Mexico from the Pecos River to the western boundary line of Cochise and Graham Counties, Ariz. It is significant that this territory produced last year a total of less than 150,000 bales of cotton, an amount which is less than the production of a single important cotton county in the Mississippi Delta. The recent spread westward in New Mexico and Arizona has already been discussed. With respect to the old areas of continuing infestation in western Texas and New Mexico, the status of the pink bollworm is about the same this year as it was last. In the Big Bend area of Texas infestation has remained uniformly high from year to year, while in the other areas there have been wide fluctuations. In one field in the Big Bend area infestation approached the saturation point by the last of October, when 96 per cent of the green bolls were infested.

In the last annual report, attention was called to several isolated infestations in volunteer patches of cotton which were found in the regulated areas and which were from 35 to 50 miles from any previously known infestation. During the 1926 crop year a similar isolated infestation was found 20 miles south of Marathon, at which place a 3-acre field of cotton was being grown. The cotton field was located 65 miles from any other cotton. The field was thoroughly cleaned in the same manner in which new infestations have been handled in the past.

SCOUTING—ALL AREAS

The field scouting of cotton as to all areas to determine the pink bollworm status totaled for the season 6,977 man-days, which compares favorably with the previous years, but an examination of the accompanying table "Summary of pink bollworm scouting showing number of man-days scouting and number of infested fields for each of the districts scouted" indicates that there has been a considerable diminution of scouting in the eradication areas in recent years. Such lessened work has been occasioned by the demands of regulatory and control work connected with the disinfection and certification of cotton for movement from infested areas, etc.—work which had to be taken care of. An effort was to have been made, however, to have very much increased the scouting as to the eradication areas in connection with the crop of 1926, with the idea of eliminating if possible any suspicion that there might be infestations undiscovered slowly building up in any of these areas. The necessity, however, of meeting the emergency occasioned by the westward spread of the pink bollworm into Arizona led to such diversion of forces and funds as to prevent the carrying out of this plan. A very considerable element of scouting of the year—and this had been carried out prior to the determination of the westward extension—had relation to points, more or less widely scattered throughout the Cotton Belt, to which seed from infested areas was traced years ago, at or near the beginning of the pink bollworm eradication effort—such scouting being with the idea of final elimination from further consideration of such areas. Similarly, it is proposed to make an intensive scouting of these eradication areas in Texas and Louisiana in connection with the crop of 1927 to make it possible to eliminate for a series of years further scouting of these areas.

Some border scouting in Mexico was conducted during the year, although much reduced over previous years for the reasons already indicated. This scouting developed the recurrence of infestation at Allende, a point only 40 miles southwest of Eagle Pass, Tex., opposite a region in the lower Rio Grande Valley at present uninfested by the pink bollworm. This finding is an illustration of the necessity of keeping constant watch over plantings of Mexican cotton close to our border.

TABLE 25.—*Summary of pink bollworm scouting showing number of man-days scouting and number of infested fields for each of the districts scouted, 1917–1926*

District	1917		1918		1919		1920		1921	
	Man-days	Infested fields	Man-days	Infested fields	Man-days	Infested fields	Man-days	Infested fields	Man-days	Infested fields
The eradication areas:										
Hearne, Tex	164	5	471	0	650	0	505	0	369	0
Trinity Bay, Tex	645	156	829	0	1,796	51	2,006	28	1,518	1
Ennis, Tex	0	0	0	0	0	0	0	0	798	5
Marilee, Tex	0	0	0	0	0	0	0	0	340	2
Cameron, La	0	0	5	0	104	22	213	0	319	0
Shreveport, La	0	0	0	0	46	0	486	10	320	0
The infested areas:										
Pecos Valley, N. M.[1]	0	0	111	0	57	0	310	2	63	4
Pecos Valley, Tex	0	0	555	9	1,123	1	850	15	299	21
Mesilla Valley, N. Mex	0	0	0	0	0	0	210	4	20	3
Mesilla Valley, Tex	0	0	0	0	0	0	30	1	7	3
El Paso Valley, Tex	0	0	103	0	158	0	339	14	78	9
Big Bend, Tex	0	0	4	18	[2,3]	1	[3]	0	22	11
Big Bend, Mexico	0	0	[3]	3	[3]	0	[3]	0	[3]	1
Juarez Valley, Mexico	0	0	0	0	0	0	0	0	0	0
San Carlos, Monclova, Mexico	[3]	4	[3]	2	17	6	[3]	1	48	7
Areas west of Mesilla Valley, N. Mex.[6]	0	0	0	0	0	0	0	0	0	0
Suspicious areas:										
Western extension	0	0	16	0	105	0	123	0	463	0
Lower Rio Grande, Tex	9	0	107	0	156	0	279	0	520	0
Lower Rio Grande, Mexico	0	0	0	0	30	0	0	0	131	0
Other areas[7]	366	0	1,278	0	1,375	0	2,663	0	4,143	0
Total	1,184	165	3,479	32	5,617	81	8,014	75	9,458	67

District	1922		1923		1924		1925		1926	
	Man-days	Infested fields	Man-days	Infested fields	Man-days	Infested fields	Man-days	Infested fields	Man-days	Infested fields
The eradication areas:										
Hearne, Tex	172	0	255	0	0	0	0	0	0	0
Trinity Bay, Tex	891	0	1,225	0	1,046	0	787	0	828	0
Ennis, Tex	671	0	740	0	835	0	606	0	566	0
Marilee, Tex	461	0	611	0	612	0	237	0	283	0
Cameron, La	632	0	718	0	655	0	649	0	661	0
Shreveport, La	332	0	648	0	826	0	606	0	568	0
The infested areas:										
Pecos Valley, N. Mex.[1]	282	0	1,212	0	741	0	626	16	97	0
Pecos Valley, Tex	386	0	421	5	650	15	183	22	32	8
Mesilla Valley, N. Mex	65	0	231	0	158	0	155	0	47	2
Mesilla Valley, Tex	12	1	0	0	140	0	17	1	1	2
El Paso Valley, Tex	261	4	406	1	397	1	131	14	114	4
Big Bend, Tex	27	24	66	36	167	62	[4]	96	[4]	-------
Big Bend, Mexico	0	0	2	3	[5]	2	0	0	[4]	-------
Juarez Valley, Mexico	5	1	0	0	0	0	2	3	27	0
San Carlos, Monclova, Mexico	5	2	26	0	40	0	37	0	36	2
Areas west of Mesilla Valley, N. Mex.[6]	0	0	0	0	0	0	0	0	528	18
Suspicious areas:										
Western extension	120	0	39	0	16	0	746	0	967	0
Lower Rio Grande, Tex	818	0	881	0	354	0	886	0	671	0
Lower Rio Grande, Mexico	0	0	35	0	34	0	16	0	15	0
Other areas[7]	2,720	0	1,860	0	777	0	687	0	1,536	0
Total	7,760	32	9,376	45	7,448	80	6,371	152	6,977	36

[1] Infestation in this valley was confined in the past to Carlsbad and vicinity and is referred to in previous reports as "Carlsbad" infestation.
[2] 0.50 man-day or less.
[3] Non-cotton zone year.
[4] Research examinations.
[5] Figures not available.
[6] Includes Safford and Duncan Valleys of Arizona and New Mexico, Willcox, Ariz., and Deming, N. Mex.
[7] Covers scouting done around centers in the Cotton Belt to which seed from infested areas had been distributed in the earlier years of the campaign of eradication. These areas were thoroughly investigated for a number of years afterwards without finding any infestation, but it seemed desirable to give them an intensive resurvey before releasing them from further consideration.

CONTROL OPERATIONS

Control operations under the quarantine on account of the pink bollworm involve the enforcement of restrictions on the movement of cotton, cottonseed, and cottonseed hulls, the supervision of seed disinfection at the gins, and the disinfection and compression of cotton as a condition of interstate movement, together with road-inspection work, inspection of cars, etc. This work necessarily increases with the growing cotton production in the infested areas and with spread of the pest. A few of the items of interest under this work are noted below:

Cottonseed heating.—The operation of the cottonseed-heating machines in connection with the gins in the infested areas constitutes perhaps the most important measure which is being carried out to prevent the spread of the pink bollworm. The heating machines operated at an average efficiency of 87 per cent throughout the regulated area, and at over 90 per cent in the most heavily infested territory, which was about the same as for the year previous, but much better than in former years.

Vacuum fumigation.—During the year 134,499 bales of cotton lint and linters were given vacuum fumigation with hydrocyanic-acid gas at the fumigation plants which are operated under the supervision of the board's inspectors. Of this number, 129,473 were produced in the regulated (i. e., infested) areas, and 5,026 were imported from the Juarez Valley of Mexico. There are at present five vacuum fumigation plants in the regulated territory, located respectively at Las Cruces and Roswell, N. Mex., and at El Paso, Marfa, and Pecos, Tex. Two additional vacuum fumigation plants are at present under construction at Fabens, Tex., and two others are in prospect at Tucson and Fort Stockton, respectively.

Road stations.—During the year, road stations were maintained at Lordsburg, Mesilla Park, Roswell, and Carlsbad, N. Mex., and Odessa, Fort Stockton, and Sanderson, Tex. A total of 89,274 cars was inspected, from which 3,194 lots of cottonseed, seed cotton, cotton-pickers' sacks, and other materials likely to carry infestation, were taken.

Inspection of railway cars.—Under the provisions of the pink bollworm regulations, railroads are required to clean all cars of cottonseed, seed cotton, and other materials before they are moved out of the regulated areas. Inspections of about 600 railway cars showed that many of them contained cottonseed and cotton lint, and while many of these cars were doubtless contaminated outside of the regulated areas, the necessity of close supervision of car cleaning is emphasized.

INVESTIGATIONS

Investigations of native plants in the Big Bend area, which might serve as hosts for the pink bollworm, were continued. During the course of the investigations, between 20 and 30 native malvaceous plants were collected. The activities of pink bollworms under field conditions in late winter and early spring were investigated. Investigations with a view to getting more information on optimum conditions for vacuum fumigation were continued.

COOPERATION WITH MEXICO

Cooperation with Mexican authorities has made it possible to greatly strengthen the administration of the pink bollworm quarantine. All cotton cultures on the Mexican side of the Rio Grande (Juarez Valley) are being effectively regulated and gins on the Mexican side of the river are maintaining cottonseed heaters giving a high percentage of efficiency.

REVISION OF THE PINK BOLLWORM QUARANTINE

As a result of the discovery of the pink bollworm in southeastern Arizona and southwestern New Mexico, a hearing was called at Washington on May 16, to consider the matter of extending the provisions of the pink bollworm regulations to the recently involved territory, and of releasing, for the present, the counties in Texas from which the insect had apparently been eradicated. Quarantine No. 52 has now been revised, providing for these changes, and adding the requirement that cotton lint to be moved interstate from the regulated areas must be compressed as well as disinfected.

During the year the State regulations of Texas were amended to include the counties of Kinney, Maverick, and Val Verde, in the Texas regulated area. Under the provisions of the new State regulations, cottonseed from these counties must go to designated mills for crushing.

THE THURBERIA WEEVIL

During the year inspectors of the department found that the Thurberia weevil had spread widely from its native haunts in the mountains of southeastern Arizona, to recently-developed cotton areas in Cochise and southern Graham Counties. Fortunately, cotton culture is a development of only the last two or three years in this section and the plantings are widely scattered. A vigorous clean-up campaign was promptly undertaken, during which all cotton acreage in Cochise County was cleaned of all stalks, bolls, locks of cotton, and other parts of the cotton plant, and all such dangerous material was burned.

In the newly infested area, there is a total of 1,500 acres of cotton, irrigated by wells, scattered from the New Mexico line west to Pima County, and infestations were discovered in all of the cotton-growing areas. Perhaps the most interesting of these was 12 miles south of Benson, Ariz., where a high percentage of bolls was attacked. So far as is known at present, there are no infested Thurberia plants closer than 12 miles, from which the weevil might have spread to this field.

On July 9, 1927, quarantine No. 61 was revised, to add these districts to the regulated area and to include a new requirement that cotton lint be compressed as well as disinfected as a condition of interstate movement.

The status of the Thurberia weevil in the newly-discovered infested areas now indicates that the board is warranted in regarding this insect as a cotton pest of the first magnitude. As shown in the report for 1926, it has long existed in the mountains of southern Arizona, attacking Thurberia which grows abundantly in the canyons of these mountains. Its ability to thrive under the hot, arid conditions of this section of the United States indicates that it may become even more injurious where irrigated cotton is grown in arid regions than the Mexican boll weevil is in the main Cotton Belt.

A total of 1,836 man-days' scouting was devoted to all areas likely to be infested with the Thurberia weevil. This included all the principal cotton-growing areas of Arizona and the western part of New Mexico. The work is combined with that of scouting for the pink bollworm, as the most effective season for searching for the two pests comes at the same time of year, namely, the fall and early winter. In Table 26, the number of infested fields and the number of man-days scouting in each of these districts is shown:

TABLE 26.—*Results of scouting for Thurberia weevil, fiscal year 1927*

District	Man-days scouting	Infested fields
Deming, N. Mex.	34	0
Duncan, N. Mex. and Ariz.	68	0
Safford Valley, Ariz.	262	0
Cochise County, Ariz.	160	14
Santa Cruz Valley, Ariz.	20	5
Florence-Casa Grande, Ariz.	82	0
Salt River Valley, Ariz.	785	0
Yuma Plantings, Ariz.	80	0
Other areas, Ariz.	345	17
Total	1,836	36

The most important methods of preventing the spread of this pest consist of compressing and fumigating the cotton lint and of heating the cotton-seed. During the season 9,391 bales were given surface fumigation. The method is to be changed to vacuum fumigation for the coming year, and a vacuum plant is being installed at Tucson for this purpose. The seed-heating treatment is applied at the gins, the heating machines in the Thurberia weevil regulated area operating at an average efficienty of 89.5 per cent. Their operation was discontinued in the Postvale area in November on account of an injunction to which later reference is made.

Road-inspection stations, to prevent the movement of cotton, cotton products, and articles contaminated with cotton, by truck from the infested districts to outside points, were operated at Sonoita, Benson, Picacho, and two points north and west of Tucson, respectively, during the fall of 1926. In view of the discovery of the Thurberia weevil in Cochise County, the stations at Sonoita and Benson are being discontinued.

On October 26, 1926, a temporary injunction was granted in the Federal court at Los Angeles, in favor of the cotton growers of the Postvale area, under the provisions of which the State of Arizona was prohibited from carrying out the State Thurberia weevil quarantine within that area. Later the injunction against the State of Arizona was made permanent.

Following the action of the court against Arizona, the Secretary of Agriculture issued a statement that the provisions of the injunction would in no manner affect the operations of the Federal Thurberia weevil quarantine. An injunction was then applied for against the Secretary of Agriculture, the Federal Horticultural Board, and their agents, prohibiting them from

carrying out the provisions of quarantine No. 61 as applied to the Postvale area. This injunction was granted on November 19, 1926.

The injunction was effective only as to the 1926 crop. Under its provisions, the court indicated that a motion for its dissolution or modification would be heard in the event that future developments warranted such request. Subsequently, infestations were found in the 1926 crop, both at Fort Lowell and in the Postvale area, and while a rehearing on the injunction was set at various times, it was finally postponed indefinitely. The result of the injunction was that after November 19, 1926, cotton was permitted to be ginned in the Postvale area without compulsory seed heating, and that agents of the board were prohibited from in any manner interfering with the movement of quarantined articles from that area. While the injunction also prevented the department from enforcing the requirement for lint fumigation, the cotton could not enter either California or Texas without fumigation, on account of regulations issued by those States, and practically all of it was therefore given that treatment voluntarily by the shippers.

At the present time the full requirements of the Federal quarantine regulations are being enforced with respect to the 1927 cotton crop throughout the entire regulated area and all the protection within the power of the department is being given uninfested districts to prevent the further distribution of this insect.

QUARANTINE ON DOMESTIC NARCISSUS

At the time commercial importations of narcissus bulbs for immediate sale, or for forcing for cut flowers, were excluded, in January, 1927, it was decided to attempt the eradication of the three principal bulb pests where they occurred in the United States, and thus secure pest-free plantings, if that should prove possible.

Under the provisions of the domestic quarantine, issued in May of that year, the interstate movement of narcissus was made conditional on certification of the bulbs, based on two inspections, the first in the field during the blossoming period, and the second in storage, after the bulbs were lifted. In case infestation was found at the time of either inspection, no interstate movement was allowed unless the bulbs were disinfected or treated under the direction of an inspector.

The enforcement of this quarantine and the supervision of the required treatments are being carried out in cooperation with the plant quarantine inspection services of the various States. The regulations were not adopted in 1926 in time to provide for field inspection that season, but storage inspection was made of all bulbs moved interstate that fall.

TABLE 27.—*Narcissus inspections reported to the department January 1, 1927, to October 1, 1927*

State	Growers issued certificates showing freedom from infestation	Growers issued disinfection certificates	Bulbs certified
	Number	*Number*	*Number*
Alabama	2	0	(1)
Arkansas	1	0	5,000
California	31	25	1,362,510
Connecticut	1	0	20,000
Florida	70	0	40,145,000
Iowa	1	0	(1)
Kansas	2	1	16,200
Kentucky	1	0	(1)
Louisiana	2	0	149,400
Minnesota	3	0	71,000
New Jersey	5	2	3,910,775
New York	14	5	6,083,167
North Carolina	6	0	166,000
Oregon	56	8	(1)
Pennsylvania	1	0	2,534
Rhode Island	0	1	(1)
South Carolina	3	0	4,545,000
Tennessee	1	0	80,000
Texas	0	1	8,637,000
Virginia	14	0	4,032,200
Total	214	43	69,225,786

[1] Number not reported.

NOTE.—The number of bulbs shown in the last column includes, in several States, estimates based on acreage, weight, or number of bushels or crates reported. States from which reports had not been received at the time of preparation of the table include: Georgia, Illinois, Maine, Massachusetts, Michigan, Mississippi, Missouri, Montana, Nevada, Ohio, Washington, and Wisconsin. Several of these States have narcissus plantings of considerable extent. Inspectors of the following States reported that their States contained no commercial narcissus plantings from which bulbs would be available in 1927; Arizona, Colorado, Delaware, Idaho, Indiana, Maryland, Nebraska, New Hampshire, New Mexico, North Dakota, Oklahoma, South Dakota, Utah, Vermont, West Virginia, Wyoming, and the District of Columbia.

In 1927, it was found that a large number of additional applications were received, and that the amount of inspection required was so great as to strain the inspection facilities of the State officers. In a number of States in which infestations of the lesser bulb fly were found, no facilities for treatment existed, and it was necessary to authorize the movement of the bulbs across a State line in order that treatment could be given. Some growers

did not apply for inspection until after the blossoming period had passed and as storage inspection alone can not be relied upon to reveal all the bulbs infested, treatment was required in all such cases.

Of the three pests concerned, namely, the lesser bulb fly, the greater bulb fly, and the eelworm, the first-named is by far the most extensively established in this country. The greater bulb fly and the eelworm, however, are limited to certain localities.

Table 27 shows the result of the State inspections so far as they have been reported at this time.

DATE-SCALE ERADICATION

Several important developments in date culture have occurred during the past year which promise to be of great assistance in completing total eradication of the Parlatoria scale affecting date palms, and which also demonstrate the importance of the work.

A method of heat treatment has been worked out in the department, which completely destroys the scales on date palm offshoots without causing permanent injury. The offshoots are held in a room at an air temperature of 185° F., until the interior of the buds reaches 128°, and the leading bud is killed. This method is proving so successful that after further tests it may be found safe to modify the Federal quarantine and provide for the movement of palms so treated from the regulated territory.

A new date-growing area is being started in the Borego Valley, San Diego County, Calif., which thus far is free from scale insects and, it is believed, can be kept so. No imported palms or palm offshoots, or those coming from infested areas in the United States, are permitted movement into that district unless given the heat treatment described.

The Parlatoria scale eradication program appears to have been successfully concluded in the Salt River Valley of Arizona, in which no infestation has been found for about four years. As will be seen from Table 28, the insects persist in small numbers at Yuma, Ariz., and in the Imperial and Coachella Valleys of California, where from 14 to 40 infested palms a month were found and torched by the inspectors during the inspection season.

The insects are extremely scarce in the four most extensive commercial plantings there, one of which has apparently been free from them for several years, and the others for nearly one year. The recent discovery of a new infestation in one of the Coachella Valley orchards was followed by an immediate and active eradication campaign.

TABLE 28.—*Results of inspections for the Parlatoria date scale from September 1, 1926, to September 1, 1927*

County	Palms inspected	Palms found infested (all were treated)
Imperial County, Calif.	2,625	67
Riverside County, Calif.	72,326	321
Yuma County, Ariz.	37,942	26
Maricopa County, Ariz.	14,848	0
Total	127,741	414

The entire project is now in a most difficult stage, the insects being so scarce that they are located by inspectors only rarely and with the utmost difficulty. The situation is such that total eradication of the Parlatoria scale is considered possible if that work can be continued vigorously. Judging from conditions in Algeria and other infested countries, and injury in the United States in past years, date production, now bringing a return of a quarter of a million dollars a year, probably can not be continued profitably in this country unless the Parlatoria scale is exterminated. Experts of the Bureau of Plant Industry estimate that the ultimate investment in this country in case the eradication program is successful, will be between $30,000,000 and $50,000,000, at the present rate of increase.

The other scale insect for which control measures are being undertaken, *Phoenicococcus marlatti*, is still strongly intrenched and is known to infest almost all of the 40,000 or more imported date palms in the United States. It is proving less injurious than the Parlatoria and is being kept under control by spraying. The scale-free date plantings being established in the Borego Valley of California, in Nevada, and other States are, however, being kept free from Phoenicococcus also.

MEXICAN FRUIT WORM

The most serious menace to American agriculture which has developed in recent years concerns the spread of the Mexican fruit worm into the lower Rio Grande Valley of Texas. This pest seems to be a native of southern Mexico, where it has long been known to infest a variety of fruits, particularly grapefruit, oranges, mangoes,

peaches, and guavas. In May the department received information that this pest was scatteringly but rather widely present in the grapefruit orchards in Cameron and Hidalgo Counties, Tex. The area in which the insect has been found in Texas is a comparatively new grapefruit-growing region, extending from near the mouth of the Rio Grande up the river about 60 miles and for a width of about 30 miles. At present about 30,000 acres have been planted to citrus trees, more than three-fouths of which are grapefruit, the other being oranges, lemons, limes, etc. Only a small proportion of these trees has yet come into bearing, the crop of 1926–27 consisting of 781 carloads by freight and 59,595 crates sent by express, a total of approximately 310,595 crates, of which 275,755 were grapefruit. The incipiency and scattered character of the infestation may be indicated by the fact that as a result of the survey conducted by this department, the Texas Agricultural Experiment Station, and the Texas Department of Agriculture during April, May, and June infested fruit was found in only 12 orchards located at various points in Cameron and Hidalgo Counties. A total of 685 specimens of the Mexican fruit worm were found, most of these, however, from comparatively few trees, the infestation being concentrated at a few points rather than general. No infestation was found other than in grapefruit and sour oranges.

Following the discovery of this pest in the region indicated, the department, in cooperation with the Texas Department of Agriculture and the local interests, secured the immediate clean-up and disposal of all hang-over citrus and other fruits in the district which could serve as hosts to carry the insect over to the succeeding year. The taking of similar measures on the Mexican side opposite Brownsville was made possible by the cooperation of public-spirited citizens and local Mexican authorities.

The existence of this fruit worm in Mexico has long been known, and realizing the seriousness of its menace to the fruit interests of this country the department, in 1913, promulgated a quarantine prohibiting the entry from Mexico of all known host fruits of the pest, and this quarantine has been enforced as strictly as possible with the inspectors available at all Mexican border ports. Infested fruit has, however, frequently been found on sale in the markets in the Mexican towns opposite the American ports of entry, and some of this fruit has undoubtedly occasionally been smuggled across for local consumption. The fact that this pest has not appeared in the lower Rio Grande Valley on the American side, where the growth of citrus and other subtropical fruits is possible, at an earlier date has evidently been due largely to the absence of fruit cultures of any importance in that district. This situation has, in recent years, been radically changed by the development of the very considerable and successful grapefruit industry in Texas in the lower Rio Grande Valley.

Early in August, 1927, quarantines were promulgated by this department and the State of Texas placing restrictions on the movement of susceptible fruits from the infested area and calling for drastic controls within the area, the latter having as their object the immediate eradication in the district concerned of this pest. These control measures include the elimination of all fruits other than grapefruit and citrus and other fruit ripening at the same time as the grapefruit and not involving increase of risk of propagating the Mexican fruit worm. Controls are placed also on permitted fruit to limit its movement out of the district to five months of the year, with the object of thus maintaining a seven-months' starvation period, i. e., in which there will be no fruit suitable for the propagation of the pest. The measures also include provision for the immediate destruction during the shipping period of fruit found to be infested as to any orchard or district within the area. By such drastic measures, taken at the very beginning of the invasion, it is believed that this pest can be eradicated and that by a continuation of these measures the area can be protected from any future or continuing reinvasion. The severity of these controls is believed to be fully warranted by the menace which this pest has to the fruit production of the southern half of the United States, including all citrus fruits and much of our peach crop.

The first phase, which was immediately undertaken, of the clean-up work of the year consisted in the destruction of the citrus fruit on the trees in commercial orchards and the clean-up of other possible host fruits. This work was begun May 24 and completed early in June. A second clean-up campaign in July was confined almost entirely to guavas. The volume of such clean-up work made it quite

apparent that the only feasible method of control would be the elimination of all fruit trees not falling within the plan of authorized commercial production, and in general this idea has been assented to with some modification. Necessarily, all such clean-up and other local work must be done in cooperation with the State of Texas and under the police authority of that State. To facilitate such work, the Texas commissioner of agriculture, at the request of the commissioners' courts of Cameron, Hidalgo, and Willacy Counties, has issued regulations which will make it unlawful for anyone to maintain fruiting trees or bushes of any of the varieties of fruit attacked by the Mexican fruit worm except citrus.

In general, the Federal and State Departments of Agriculture are receiving the hearty cooperation of the producers in the valley, as well as the local officers, all of whom realize the serious nature of the pest and the disaster which a general infestation would bring about. It is believed that by maintaining an eradication campaign of this kind it will be possible to ship fruit safely from the regulated area during the months from October to February, inclusive, under inspection and certification, without incurring any danger of spreading the fruit worm to other regions.

ECONOMIC IMPORTANCE

The menace of this pest to the citrus industry of this country, including other fruit production certainly over the lower half of the United States, has already been alluded to, and this menace extends to practically all tree fruits. In the case of citrus fruit, the presence of the maggots in the fruit can not usually be determined until a fairly late stage, and therefore infested fruit may be shipped in ignorance of such infestation and thus be a means of spreading the pest widely. Incidentally it may be noted that the United States is the only country in which citrus and other fruits are free from the important fruit flies which infest practically all other countries of the world, and even a small percentage of such infestation in citrus fruit which would not be discovered until the fruit was eaten would create public distrust and might greatly reduce the demand for this fruit. The parent of the Mexican fruit worm is a small fly (*Anastrepha ludens*) scarcely larger than the house fly, but of brownish color and with the wings crossed by oblique dusty bars. This fly places its eggs directly in or through the skin or rind of fruits and the maggots develop in the fruit which, as indicated, may appear perfectly normal until the maggots have reached nearly full growth and begin to puncture the fruit preliminary to their escape for transformation in the soil.

ERADICATION PROGRAM

As already indicated, the work that was immediately instituted had for its object the eradication of this pest to maintain if possible this fruit district in the lower Rio Grande Valley free from it in the future. The immediate clean-up work was conducted by cooperation of the Federal Horticultural Board with the State authorities and the residents of the district concerned. It was possible for the pink bollworm inspectors working in that district to give a good deal of aid to this work. There being no funds, however, available or possible of being diverted under the law under the appropriations for the Federal Horticultural Board to continue such work of control, the sum of $30,000 was made available from the appropriations to the Bureau of Entomology and this work of quarantine enforcement is now being temporarily carried out by that bureau, in cooperation with the board, and a supplemental emergency appropriation of $100,000 has been requested to finance this work for the fiscal year 1928, $80,000 of which will be used for control operations, leaving $20,000 available to initiate research work. Beginning with the fiscal year 1929 it is proposed that the quarantine work shall revert to the board and that all biological and other research will continue with the Bureau of Entomology.

NEW AND REVISED PLANT QUARANTINES

DOMESTIC

The following quarantines have been either promulgated or revised during the year:

The European corn borer quarantine, amended August 4, 1926, to include additional infested territory in Ohio, revised November 23, 1926, to include the States of Indiana and West Virginia, bringing shelled corn and seed of broomcorn under the requirement of inspection and certification, providing for the disinfection of any restricted articles found to be infested, and providing for the inspection of restricted plants and plant products in transit was revised February 15, 1927, to include the States of Connecticut and

New Jersey, and additional infested territory in Rhode Island and New York, and amended August 6, 1927, to simplify the conditions governing the movement of shelled corn.

The gipsy moth and brown-tail moth quarantine was revised May 17, 1927, releasing 13 towns in Vermont and 2 in Connecticut from quarantine, and placing restrictions on the interstate movement of certain plants not grown in nurseries—plants not covered by the former regulations.

The Japanese beetle quarantine, amended July 3, 1926, to permit the use of hay and straw for packing articles other than fruits and vegetables, revised October 2, 1926, to include the States of New York and Connecticut, and extending the areas under regulation in New Jersey, Pennsylvania, and Delaware, amended November 17, 1926, to provide for unrestricted movement of imported nursery stock from a port within the regulated area when reshipped from such port in original containers, was revised March 21, 1927, to correct wording and arrangement, and to transfer to the appropriate regulations much of the matter theretofore carried in the appendix, was amended June 18, 1927, to include two additional townships in Pennsylania in the regulated area, and again amended August 3, 1927, to require inspection and certification of all farm products and cut flowers produced in the infested area and moving interstate by boat from New York City.

The narcissus bulb quarantine was revised April 15, 1927, slightly modifying the conditions governing interstate movement of narcissus bulbs to meet conditions which have grown out of the first year's experience under the quarantine.

The white-pine blister rust quarantine (No. 63 supersedes Nos. 26 and 54), promulgated August 27, 1926, prohibiting or restricting the interstate movement of five-leafed pines, currant and gooseberry plants throughout the United States, was revised February 17, 1927, to correct minor errors in the original edition and to make more clear the requirements governing interstate movement of the plants concerned.

The satin moth quarantine was revised October 30, 1926, to include the State of Connecticut and extend the infested areas in Rhode Island, Massachusetts, New Hampshire, and Maine.

The pink bollworm quarantine was revised July 9, 1927, to include the State of Arizona, to add three counties in New Mexico to the regulated area, and to require the compression as well as disinfection of cotton lint as a condition of interstate movement.

The Thurberia weevil quarantine was revised July 9, 1927, to include all of Cochise and part of Graham Counties, Ariz., in the regulated area, to require the compression as well as disinfection of cotton lint as a condition of interstate movement, specifying the conditions for interstate movement of cottonseed cake and meal, bagging and other containers of cotton, farm household goods, farm equipment, and other articles contaminated with cotton, and prohibiting the interstate movement of the Thurberia plant from any portion of Arizona.

The Mexican fruit worm quarantine was promulgated August 10, 1927, restricting the interstate movement from the counties of Cameron, Hidalgo, and Willacy, Tex., of host fruits in the raw or unprocessed state.

FOREIGN

The European corn borer quarantine, revised December 16, 1926, to limit the entry of products covered thereby to clean shelled corn, clean seed of broomcorn, and broomcorn for manufacture, was revised February 10, 1927, superseding the quarantine against Mexican corn, and requiring the securing of permits for the entry of broomcorn for manufacturing brooms or similar articles made of broomcorn, clean shelled corn, and clean seed of the other plants covered by the quarantine, and amended July 5, 1927, to provide for the entry, under permit and upon compliance with the regulations, of green sweet or sugar corn on the ear.

The nursery stock, plant, and seed quarantine was revised March 17, 1927, to incorporate in one document the quarantine and regulations thereunder and the four amendments to the regulations issued subsequent to the last edition, and making certain minor changes in regulations 4, 7, and 15.

TERMINAL INSPECTION OF MAIL SHIPMENTS OF PLANTS AND PLANT PRODUCTS

The terminal inspection points in Mississippi, Arkansas, and Utah, for the inspection of mail shipments of plants and plant products under the authority of the act of March 4, 1915, were revised during the year. No additional States inaugurated terminal inspection during the fiscal year 1927. The following States are now maintaining such inspection: California, Arizona, Montana, Florida, Washing-

ton, Arkansas, Mississippi, Utah, Oregon, Georgia, Idaho, and Oklahoma; also the District of Columbia and the Territory of Hawaii.

CONVICTIONS AND PENALTIES IMPOSED FOR VIOLATIONS OF THE PLANT QUARANTINE ACT

The following convictions and penalties imposed for violations of the plant quarantine act were reported to the board during the year:

White-pine blister-rust quarantine (No. 26): Sixteen convictions, with fines aggregating $405 imposed.

Japanese-beetle quarantine: Fifteen convictions, with fines aggregating $1,135 imposed.

Nursery stock, plant, and seed quarantine: Two convictions, the defendant in one case being fined $95, and in the other case being sentenced to serve 29 days in jail. The sum of $5,000 was also received covering liquidated damages tendered by one importer for violating the liability agreement entered into by his agent.

Quarantines affecting Mexican products: Ten convictions, with fines aggregating $380 imposed. Fines aggregating $55 were also imposed by customs officials on the Mexican border against 11 persons who were caught while attempting to smuggle in from Mexico prohibited plants and plant products.

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REPORT OF THE FORESTER

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., September 1, 1927.

SIR: I have the honor to transmit herewith the report of the Forest Service for the fiscal year ended June 30, 1927.

Respectfully,

WILLIAM B. GREELEY, *Forester.*

HON. W. M. JARDINE,
Secretary of Agriculture.

FORESTS AND FLOOD CONTROL

The Mississippi flood disaster has called in question the adequacy of our public program of forestry. That such floods can be controlled solely through reforestation is patently impossible. Serious floods occurred in the Mississippi before the natural forest cover of its drainage basin had been disturbed by settlement or lumbering. The flood of 1927 was caused primarily by very heavy rains in the lower valleys. Engineering works alone can restrain the vast quantities of water poured into the channel of the river under such circumstances.

On the other hand, forests aid in the regulation of streams because they hold the soil in place and hold back rain and snow water more effectively than any other form of vegetative cover. This beneficial influence of forests has been widely recognized the world over and widely demonstrated in the experience of the United States. It has been accepted in our national policies for the conservation and extension of forests, specifically in the statute authorizing national forests and defining their purposes and in the Weeks law providing for their extension on the headwaters of navigable rivers. The influence of forests upon stream flow must be gauged with sanity and common sense in consideration of the physical conditions which actually produce great floods. Forests have a place in the plan for dealing with the Mississippi River—but a place that can not be defined in sweeping or general terms. It can be determined only by study of the facts to ascertain where, in the Mississippi Basin, the improvement or extension of forest cover will be of tangible help in supplementing the engineering works upon which the main reliance for the control of destructive floods must be placed.

The control of Mississippi floods is fundamentally an engineering problem, but a broader one than that term might at first suggest. The watershed of the Mississippi extends from the southwest corner of New York to the Panhandle of Idaho and from southern Saskatchewan to the Gulf of Mexico, with a corresponding diversity in all of the factors of topography, soil, climate, and surface cover which influence the regimen of streams. From this vast watershed there will continue to be delivered to the lower river from time to time volumes of water far beyond the capacity of its natural channel to discharge. To store, restrain, or direct these flood waters within set limits through engineering works is the most immediate and acute phase of the problem.

But as we follow the major tributaries of the Mississippi back to their source, the central engineering problem ramifies and new aspects of river regulation appear. The coincidence of high-water discharges, or the lapse of time between them, from the many different tributaries is seen to be a factor of importance. The rapidity with which the winter snowfall is converted into spring freshets, the ex-

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tent to which lakes or swamps afford natural flood storage, the capacity of the soil to hold water, the extent to which naked, impervious soils accelerate run-off and erosion, and the presence or absence of surface reservoirs in the form of forests or well-sodded pastures or well-tilled farms are all found to be of significance in the behavior of the innumerable feeder streams and hence in the total volume of water flung into the main channel during the period of flood crests.

Many of these elements which affect surface run-off and erosion are beyond human influence. But the further back study of the facts is carried the more obvious it becomes that what man does with the land has an important bearing on its run-off, that the surface conditions where floods originate are not static but shifting and progressive, and that to attain the most complete control of floods prevention of the rapid movement of water and silt at the source of rivers is necessary no less than structures for controlling the results of such movement in their lower channels.

This study of the land and what we are doing with the land brings forestry into the picture as a means of restraining flood conditions at their source. Forests can not prevent floods, but can reduce them. They retard the melting of snow. They retard surface run-off both directly and through the greater porosity of the underlying soil which they maintain. They retard erosion and reduce the silt burden of streams. Their relative influence in these respects may be greater or less in comparison with the many other factors which affect the regimen of streams. It can not be separated and measured in exact, quantitative terms. Nevertheless it is an influence which should be brought into play in the progressive betterment of conditions which contribute to destructive floods.

SURVEY NOW IN PROGRESS

Following the conference on flood control held in Chicago last June and conferences with the Corps of Engineers of the War Department, the Forest Service undertook to assemble all available data regarding the areas where forests do or can exert a helpful influence on the flow of the Mississippi and where protective forests should be extended. For the purpose of this survey, "protective forests" were defined as "forests which, because of the steepness of the slopes, erodible soil, or the character of the precipitation, exert directly a beneficial influence upon the behavior of streams." Manifestly where such conditions obtain forest destruction is followed by increased erosion and greater irregularity of stream flow. This survey has been undertaken with a view to presenting its results for consideration when final plans for flood control on the Mississippi are drawn.

For the purposes of the study the Mississippi watershed was divided into five main tributary basins, each subdivided into minor drainages. The amount, character, and seasonal distribution of the precipitation in each drainage basin, the location and character of the different types of physiographic features, such as altitude, slope, ruggedness of topography, and natural reservoirs in the form of lakes, swamps, and overflow lands, and the location, character, and extent of the various classes of vegetative cover now occupying the land will supply a basis for rating (1) the protective value of the various areas on each watershed and (2) the efficiency of the protective cover now present on each area. Compilation will also be made of all available records as to high and low stages of the streams, the average dates of the occurrence of flood stages, and the burden of sediment carried. Upon the assembly of this information, summaries will be prepared showing for each watershed the aggregate forest area of protective significance and its location, and where the protective value of lands now without an adequate forest cover makes reforestation desirable.

While any definite program for employing forestry as a means of flood prevention on the Mississippi must await the completion of the survey now in progress, it appears probable that no additional organic legislation will be required.

A need will undoubtedly appear for the extension of public forest ownership under the Weeks law or the Clarke-McNary law in the mountainous drainages where the natural balance between topography, soil, and cover is easily upset and surface conditions augmenting flood discharges are easily brought about by destructive lumbering, forest fires, or temporary and shifting agriculture. Need will undoubtedly also appear for intensifying the protection of forests from fire on critical drainages of the Mississippi through enlarged cooperation between the States and the Federal Government under the Clarke-McNary Act. Forest

planting should undoubtedly be promoted aggressively on abandoned or eroding farm lands and denuded forest lands where erosion and run-off are now serious. This, too, is authorized by the Clarke-McNary Act through cooperation with the States, although with a present limitation to farm lands which should undoubtedly be removed.

National leadership and the need for national action should be fully recognized; but the fullest measure of cooperation with the States and landowners immediately concerned should be secured.

To sum up the situation in a word, the behavior of our great rivers and the plans projected for their control can not be separated from the use of land. Behind the great floods in the lower Mississippi lie 800,000,000 acres of land—farms, pastures, ranges, and forests. The conservation and productive use of this large part of the soil of the United States fully justify on its own account all of the foresight and National and State action that can be brought to bear. The loss of farm soils and farm fertility through erosion is a national loss greater in the long run than the property damage created by destructive floods. The creation of productive forests and improved pasture lands will pay dividends on their own account greater than the aid they will render to the regulation of rivers. The main point to be borne in mind is that just as the condition and use of the land have a part in flood prevention, so is the protection of streams one of the inseparable national benefits obtainable through a sound policy of land use.

THE SITUATION IN PRIVATE FORESTRY

There have been no marked changes during the year with respect to the growing of timber on privately owned lands, and there is little prospect of any sudden or striking change. Forest-land practices are undergoing a slow and gradual evolution, and some time must elapse before the results can be appraised in specific terms. The progress in farm forestry is relatively more rapid and pronounced than in industrial forestry. This is indicated by the emphasis now given to forestry in agricultural extension work, by the steady increase in the scale of timber planting on farms, and by the many instances in which timber production is taking more definite form as a farm or farm-community activity.

Industrial forestry on lands of lumber companies, paper companies, railroads, and like owners is gaining ground slowly. Encouraging indications of change in the attitude of such owners toward the possibility of growing timber on their land or of adopting reforestation plans are evident every year. The net gains, however, still fall far short of providing for the future productivity of the 242,000,000 acres of forest land in industrial ownership. The area of cut-over land left in poor productive condition is still enlarging, though probably at a substantially lower rate than 10 years ago. The current growth of timber is probably increasing in response particularly to the expanding protection of cut-over lands from forest fires, but still is far short of replacing the current drain upon the forests. To a degree which has never existed before, industrial forest-land owners are interested in the possibilities of forest management; but a long time will be needed to work out the many problems involved and to make the forests of the country currently self-sustaining.

Among the difficulties which stand in the way are the current depression in lumber markets, the financial obligations imposed by existing investments in plants or timberland, the uncertainty as to the future course of taxation in respect both to merchantable timber and young forest growth, and the burden of raw material wastes still carried by most forest industries of the United States.

Timber waste is standing out more and more clearly both as one of the major handicaps of our forest industries and as one of the most promising lines of attack in promoting industrial forestry. To the extent that a timber crop can be given greater value and utility through closer and more profitable ways of using it, the growing of timber will be encouraged. Some very encouraging developments are taking place in this field. The extension of pulp and paper manufacture in the Northwest is opening a way for profitable use of sawmill and logging wastes which are now a heavy drag upon the lumber industry of the region. The National Committee on Wood Utilization and other agencies are promoting the use of short lumber lengths, small-dimension stock, and other material, all of which tends to lessen waste and enhance the value of forests. In fact, the active search for and development of ways to utilize timber more closely is both a striking proof of the gradual change in the forest industries of the

United States due to the depletion of virgin forests and one of the things most necessary for stable forest industries and paying forestry.

Cooperative public effort is now well organized for overcoming the formidable barriers against forestry created by the hazard of physical loss from forest fires and the hazard of financial loss through burdens beyond the capacity of timber growing to bear. Public and private agencies are working steadily toward more complete and profitable use of timber. A good deal is being done on technical questions of forestry practice, timber yields, and the best methods of harvesting and removing the timber crop. As yet, however, no adequate attack has been begun on many economic questions which must be answered before private land management can be soundly directed toward industrial forestry. This gap should be filled without delay, and public leadership in filling it is greatly needed.

All-round stability of our forest industries is necessary to progress in forestry, and the extension of timber growing on commercial holdings will, by and large, come about only as this stability is attained. The large private holdings of stumpage in the West are proving to be one of the serious causes of instability, affecting not only the forest industries in that region but also many in eastern regions through competition in common markets. The financial difficulty in carrying large timber holdings over long periods of time is forcing many owners to cut as quickly as possible and tends to create an overproduction of lumber. This both causes a rapid and wasteful use of the only large supply of virgin timber remaining in the country and deters private forestry. A difficult problem is presented, which needs to be given consideration in connection with public policies and which merits public assistance for its solution.

In general, the forest industries are giving wider consideration than ever before to applying the principle of sustained yield of timber as a working business policy. Under this principle only as much timber is cut yearly from a given unit of forest land as the land is replacing through growth, so that a manufacturing plant of corresponding capacity can be permanently maintained. Sustained yield is, of course, the underlying idea and essential aim of all forestry. We shall not have solved our national problem until the country as a whole is on a sustained-yield basis, with timber production balancing current use. To the individual lumber or paper or other forest industry the sustained-yield conception offers the most rational basis for stabilizing an enterprise throughout. If the forest industries of the West, where large quantities of virgin timber are still available, could forthwith be placed on a sustained-yield basis, the current output of forest products would not be materially curtailed but expansion would be held down, overproduction would be cured at its source, and a rational stability would be introduced into all phases of industrial planning. There is no question that such a development would be in the public interest through conserving and extending the period of use of the remaining virgin timber.

For many of the larger forest industries in the Eastern States, a sustained yield can be attained only after a considerable period of forest restoration and would involve, for a time at least, a reduction from the present rate of cutting. To the business executive, East or West, application of the sustained-yield principle necessarily presents both financial and other difficulties, and it can be expected to gain ground but slowly. It is desirable, however, to recognize that the general reorganization of our forest industries around the sustained-yield conception is necessary, that its accomplishment is the great goal to be sought in connection with the use of forest lands, and that the rate of advance towards that goal will be a conclusive index of our progress as a Nation in forestry.

The whole situation creates urgent reasons for a broadened program of public forest ownership in regions where industrial forestry may thus be most effectively stimulated and supplemented. The southern pine belt and the northern Lake States are outstanding examples. From these two regions much of the softwood timber needed by the Nation in the past has been supplied; and for large sections of the United States they represent the logical and economical future source of such material as well as of other forest products. The timber resources of both regions have been severely depleted. Many large industrial units have exhausted their virgin stumpage and moved out. The southern pine industry and the southern naval-stores industry are finding a new lease of life in the second-growth timber which has come in extensively after logging or on abandoned farm lands. Broadly speaking, in these two regions the forest industries are farthest from the sustained-yield conception. In both,

large areas of cut-over and denuded land have accumulated whose restoration to productive forests is essential from a regional as well as a national standpoint.

Industrial forestry is gaining ground in the southern pineries and the Lake States, but its progress is wholly inadequate to the regional and national needs. At best a serious hiatus in time is bound to occur between the severe depletion of existing timber supplies and the resumption of forest industries on a sustained-yield basis, and this hiatus will be lengthened by whatever period is consumed in bringing back into production these large acreages of cut-over land through the slow and relatively costly process of reforestation.

Of the original forest area in the two regions of more than 330,000,000 acres, from which the Nation has hitherto drawn timber heavily, approximately three-fifths is now classed as forest, but with less than one-eighth virgin forest, while more than 50,000,000 acres, or over one-fourth of the present area of forest land, is unproductive in varying degrees. With every possible extension of industrial forestry that can be anticipated, there is an imperative need for more aggressive public action to aid in restoring the cut-over lands of these two regions to productive forests and in making them fulfill their part in providing a national sustained yield of timber.

In addition to everything that can be done to encourage industrial forestry through research, protection from fire, and the solution of tax and other economic problems, the southern pine region and the northern Lake States particularly call for the extension of public forest ownership. State and national forests would not only restore to timber production the land areas actually embraced in them but also would, as local demonstrations of forestry practice, aid greatly in promoting private forestry around them. In the southern pine region national forests in units of about 100,000 acres each, well distributed and harmonized with the plans of the States for the creation of State forests, would contribute substantially to the working out of the tremendous land problem of that region. In the northern Lake States, a few additional national-forest units of somewhat larger size are needed. In both regions a great increase of State forests is equally important. There is ample room and urgent need for all that the States and the Federal Government combined can do, through public forest ownership, toward a solution of the regional land problem.

PROGRESS IN STATE FORESTRY LEGISLATION

The increasing interest throughout the country in forestry was evidenced by the legislation of a number of States during the past year. Florida, South Carolina, and Delaware passed laws for the establishment of State forestry departments and the appointment of State foresters. Similar legislation was again proposed in Arkansas, but failed. California created a department of natural resources, under the general supervision of a director, with a division of forestry administered by the State forester and guided as to policies by a State board of forestry. This new department takes over all the powers and duties of the former State forester.

Rhode Island made an important change in its forestry organization by putting it under the department of agriculture, North Carolina revised the board of conservation and development to consist of a membership of 12 instead of 6, and Louisiana provided for an additional member on its forestry board. Virginia created a department of conservation and development, consisting of the conservation and development commission and two other commissions. This change did not, however, materially affect the status of the forestry work of the State, since the conservation and development commission was already in charge of it.

Ohio authorized the board of control of the Ohio Agricultural Experiment Station to acquire representative tracts suited for research and demonstration in practical forestry. Maine provided for the establishment and management of town forests, and Wisconsin made similar provision for county forests. Washington authorized the State to accept from counties tax lands suitable for State forests, Michigan provided for the retention of such lands by the State, and Minnesota set aside all State lands within the boundaries of the Minnesota National Forest as State forests. Pennsylvania made an appropriation of $450,000 toward the acquisition of about 7,200 acres of private land in order to preserve a portion of the original forests of the State and for other forests and parks, subject to the contribution of not less than $200,000 of private funds for the

same purposes. Maryland authorized the formation of auxiliary State forests through agreement with private landowners, and as a step toward an enlarged program of State-owned forests repealed the law authorizing Federal land acquisition for national forests.

Much of the State forest-fire legislation was revised. To cite only some of the more important cases: In Montana the State board of land commissioners may now contract with organized protection agencies for the protection of State lands, and uncontrolled or spreading fires between May 1 and September 30 are declared a public nuisance which the landowner must make reasonable efforts to abate. Oregon also reshaped its fire legislation. Delinquent fire-patrol assessments are to bear the same interest rates, costs, and penalties which apply to ad valorem property taxes. Owners or operators responsible for starting fires are also made responsible for their suppression, without regard to whether the fire spreads to other land. California, in revising her fire laws, shortened the open deer season in the Sierras, authorized closing forestry areas to campers, made the building of fires on posted lands a misdemeanor, and bettered the law concerning clearing around logging engines. Washington regulated the burning of waste material due to logging and land clearing. New York extended her intensive protective system to two additional fire towns and added a new forest-ranger district to the State organization. Nevada made provision for the organization of county fire patrols. Utah authorized the boards of county commissioners to designate fire districts, declared uncontrolled fires a public nuisance, and provided for their abatement. Wisconsin materially strengthened and enlarged its protective organization and also created an interim committee of the legislature to investigate all phases of the forestry situation in the State and formulate a comprehensive policy.

The most outstanding legislative measures, however, were aimed at encouraging the growing of timber. California, Louisiana, Minnesota, and Wisconsin amended their constitutions to permit changes in the taxation of forest lands, and Louisiana and Minnesota passed laws putting such amendments into operation. In Illinois and Washington amendments for the same purpose failed of ratification. Kentucky's forest-taxation law was declared unconstitutional by the attorney general of the State "on the ground that the constitution prescribes that all lands shall be assessed at its true sale value, while the act sets $2.50 as the maximum."

Especially noteworthy were the developments in Minnesota and New York. Minnesota created an interim commission to study and report to the legislature on the forestation of lands, delinquent real estate taxes, and financing counties and taxing districts in the forest areas of the State. It also directed the commission of conservation to make recommendations covering all lands owned by the State which are suitable for forestation purposes, and enacted a comprehensive measure for the forestation of lands under limited and special taxation as contemplated by the so-called "forestation amendment" to the constitution. In New York a concurrent resolution was introduced proposing an amendment to the State constitution to authorize a bond issue of not to exceed $5,000,000 a year for 20 years, or $100,000,000 all told, for the acquisition and reforestation of lands and the establishment of such additional forest-tree nurseries as may be needed to grow sufficient planting stock to reforest 200,000 acres each year. While this resolution was not acted upon, it is nevertheless significant that effort was begun to plan the State's reforestation work upon a scale of such proportions.

On the whole, it is evident that the States are becoming more and more alive to the importance of forestry and the necessity of progressively developing their forest policies.

COOPERATION WITH THE STATES IN FORESTRY

Cooperation with the States in forestry under the Clarke-McNary law completed its second year with appropriations that totaled $835,000. Its object is to encourage the protection of forest and water resources and the continuous production of timber on lands chiefly suitable for that purpose. It seeks to do this by promoting permanent and adequate protection against fire of all classes of State and private forest land, whether timbered, cut-over, or burned, and of watersheds supplying water for domestic use or irrigation; by a comprehensive study of forest taxation; by supplying farmers with young forest trees for planting idle lands, windbreaks, and shelter belts; and by giving farmers advice in the proper handling of their already established woods.

The law authorizes appropriations up to the following limits:

For the prevention and suppression of forest fires, and investigations in forest taxation and timber insurance	$2,500,000
For the distribution of forest planting stock to farmers	100,000
For farm forestry extension	100,000
Total	2,700,000

The Clarke-McNary law is proving a powerful stimulus for bringing together the Federal Government, the States, and the private owners in a joint cooperative effort to promote the growing of forest crops. Forty-two of the States, in addition to the Territories of Hawaii and Porto Rico, and thousands of private owners are cooperating under one or more sections of the law.

The progress which has been made in the study of forest taxation is described on page 41; that in the other activities of the law is briefly given below.

PROGRESS IN THE STUDY OF PROTECTION REQUIREMENTS

Under section 1 of the Clarke-McNary law the Forest Service cooperates with State forestry departments, private forestry associations, or other interested organizations in studying the forest-fire protection problems of States or regions and in devising or approving programs which set forth the measures essential to permanent and adequate protection of forests against fire. The Forest Service, working with the cooperating agencies, helps to formulate the specific measures of fire protection in each forest region or State which seem essential to keep forest lands in continuous production and appear equitable to all interests concerned, assists in giving these measures publicity with a view to bringing about their general consideration, and indorses or recommends State or Federal enactments necessary to effect the application of such measures.

During the year reports dealing with the economic relationship between timber supply and forest fires and with the fire-protection measures needed were prepared in cooperation with the Florida Forestry Association and the State forestry departments of Idaho, Maine, and Montana. The published report on the Florida study was given wide distribution and undoubtedly helped to draw attention to the need for a State forestry department, which was established late in the year.

One of the most interesting and valuable projects under section 1 of the law is that in Massachusetts known as the Cape Cod forest-fire prevention experiment. Its aim is to throw light on the relative cost and value of educational preventive work for fire control as against provision for fire suppression merely. The experiment began in January, 1926, and will run three years. Cape Cod has one of the highest forest-fire hazards in the Eastern States. The project was initiated by the Massachusetts Forestry Association in cooperation with the State conservation department, the local boards of selectmen, and the Federal Forest Service.

Expenditures thus far have been 11 per cent less than under the old system of fire suppression alone, and the losses and acreage burned have been reduced by 72 per cent during two exceptionally bad fire years. The demonstration that forest fires can be prevented at reasonable cost has made the public ready to consider the next step in a reforestation program. In consequence, a joint committee representing the Cape Cod Chamber of Commerce and the Massachusetts Forestry Association is being formed to study the reforestation problem and to prepare a working plan under which the State, the towns, and the private landowners may join in the local task of reclamation and forest conservation.

In Mississippi and Oklahoma fire plans were prepared for sample protective units. They covered forms of organization, the duties of key men, methods for detecting and reporting fires, and plans for mobilizing and transporting fire crews. Of chief importance is the program of action to prevent fires through general education and the curtailment of known fire risks.

In the Southeast the fact-finding surveys begun in the previous year were conducted by State forestry departments in cooperation with the Forest Service. These surveys will eventually bring together in definite form all available information bearing upon the various phases of forest-fire protection and will enable recommendations to be framed regarding the measures necessary to meet each major protection problem. The aim is to formulate a program for each forest region or State to which all parties are agreed and for which all will strive.

PROTECTION OF STATE AND PRIVATE FORESTS FROM FIRE

Continued progress in the protection of State and private forest lands from

fire was made possible in part by a slight increase in the Federal funds available for allotment to the cooperating States, but principally by larger State appropriations and greater participation by private agencies. Yet the combined Federal, State, and private expenditures have yet to reach the half-way mark toward the estimated $10,000,000 required annually to protect our forest lands.

Although there was no increase during the year in the number of cooperating States, Florida, South Carolina, and Delaware enacted legislation which will enable them to qualify for assistance. Of the 39 States having substantial areas of State and private forest land in need of protection, only Arkansas, Illinois, and Indiana have yet to qualify for cooperation.

A Federal appropriation of $710,000, State funds amounting to $1,900,000, and $684,000 derived from private sources were available for cooperative expenditure. In addition, about $1,500,000 was expended independently by private individuals and associations for forest protection. The latter is not included in Table 1, which shows only sums either actually disbursed by the States or expended under their direct supervision. In some of the States private expenditures which do not appear in the table far exceeded those which do. The figures given should, therefore, not be taken as indicative of the total protection effort, but merely that part of it which was made in direct connection with State systems of organized protection.

TABLE 1.—*Cooperative expenditures in fire protection and the distribution of forest planting stock under the Clarke-McNary Act, fiscal year 1927*

State	Fire protection				Distribution of forest planting stock		
	Federal	States	Private agencies	Total	Federal	States	Total
Maine	$30,436.49	$158,991.98		$189,428.47	$1,196.16	$1,544.74	$2,740.90
New Hampshire	8,366.41	31,473.69		39,840.10	2,280.00	5,208.00	7,488.00
Vermont	4,960.57	7,078.03		12,038.60	2,250.00	6,771.66	9,021.66
Massachusetts	14,230.00	63,543.84		77,773.84	2,510.00	7,980.38	10,490.38
Connecticut	4,440.00	28,679.67	$806.84	33,926.51	1,145.81	1,145.80	2,291.61
Rhode Island	709.52	3,776.33		4,485.85			
New York	28,750.00	206,669.44		235,419.44	6,120.00	49,593.73	55,713.73
New Jersey	5,734.48	72,070.89		77,805.37	1,769.89	2,349.24	4,119.13
Delaware					249.99	250.01	500.00
Pennsylvania	29,120.00	106,946.02		136,066.02	5,630.00	51,218.05	56,848.05
Maryland	4,880.00	15,770.68		20,650.68	2,150.00	3,867.00	6,017.00
Ohio	2,060.00	14,174.44		16,234.44	2,800.00	15,900.75	18,700.75
Indiana					2,000.00	3,401.23	5,401.23
Iowa					2,080.00	3,000.00	5,080.00
Virginia	26,980.00	22,784.16	4,403.00	54,167.16	1,610.41	1,610.43	3,220.84
West Virginia	11,462.80	29,421.22	10,750.25	51,634.27			
North Carolina	32,943.79	31,784.57	1,159.22	65,887.58	1,700.00	1,767.98	3,467.98
Kentucky	9,500.00	8,833.43	855.27	19,188.70	2,340.00	6,398.02	8,738.02
Tennessee	15,740.51	12,109.46	3,631.07	31,481.04			
Georgia	14,920.00	9,000.22	18,499.23	42,419.45			
Porto Rico					2,508.91	10,626.82	13,135.73
Alabama	33,600.00	44,209.42	23,378.85	101,188.27	1,550.00	1,550.13	3,100.13
Louisiana	25,320.00	70,311.71	29,606.00	125,237.71	2,230.00	7,429.00	9,659.00
Mississippi	17,810.00	10,700.93	11,358.20	39,869.13			
Texas	26,580.00	28,800.50		55,380.50			
Oklahoma	8,020.00	3,889.47	20,658.43	32,567.90	903.83	903.87	1,807.70
Missouri	5,808.96	5,808.96		11,617.92	1,821.28	2,578.94	4,400.22
Michigan	37,080.00	332,519.12		369,599.12	2,250.00	6,116.62	8,366.62
Wisconsin	23,750.00	64,954.06		88,704.06	2,050.00	5,249.35	7,299.35
Minnesota	43,030.00	154,162.47		197,192.47			
Kansas					2,170.00	6,026.00	8,196.00
Nebraska					720.00	1,598.80	2,318.80
Colorado					1,703.00	1,747.90	3,450.90
South Dakota	120.00	6,663.99		6,783.99			
Wyoming					1,000.00	1,290.32	2,290.32
North Dakota					2,220.00	4,426.95	6,646.95
Montana	15,470.00	15,380.28	1,408.27	32,258.55	650.00	849.24	1,499.24
Idaho	26,280.00	97,116.55	273,415.93	396,812.48	880.00	880.00	1,760.00
Washington	35,700.00	72,171.37	111,942.54	219,813.91	2,582.00	3,182.65	5,764.65
Oregon	31,530.00	41,877.94	133,891.85	207,299.79	2,000.00	2,069.23	4,069.23
California	30,420.00	75,428.84	38,376.87	144,225.71	790.00	7,304.17	8,094.17
Hawaii					2,250.86	15,901.25	18,152.11
New Mexico	1,400.00	5,683.00		7,083.00			
Administration and inspection	60,462.28			60,462.28	3,082.47		3,082.47
Total	667,615.81	1,852,786.68	684,141.82	3,204,544.31	71,194.61	241,738.26	312,932.87
Forest tax studies	35,972.24						
Unexpended balance	6,411.95				3,805.39		
Total appropriation	710,000.00				75,000.00		

The calendar year 1926 was one of severe fires in various regions. In the Northwest and on the Pacific coast it can be compared only with the disastrous years of 1910 and 1919. In the Lake, Central, and Northeastern States a dry spring season taxed the strength of the protective organizations. In the Southeastern States both the number and the extent of the fires was again unusually large. The total number for the entire country, 91,793, was exceeded only in 1924. On the other hand, the area burned, 24,316,000 acres, and the damage to timber and improvements, $26,912,000, were appreciably below the previous year, which was itself rather under the average in both items. It appears probable that the increasing extent and efficiency of organized protection is evidenced in the records.

With the growing public interest in the protection of forests has come a demand for more detailed information on forest fires. The increased efficiency of the protective systems made it possible to gather the statistics for 1926 in a more comprehensive fashion than previously. Table 2, therefore, shows some new features. A distinction is made between protected and unprotected lands, which permits of a fairer comparison of the records of individual States as well as between the States in the various groups. The new classification of the various types of protected lands decreases the possibility of a misconception by the public as to the character of the areas burned and extent of the damage done.

The number of fires reported for 1926, the damage caused, and the area burned in the several forest regions are shown in Table 2.

TABLE 2.—*Summary of forest fire statistics, by groups of States, for the United States, exclusive of Alaska, 1926*

Group of States [1]	Number of fires				Damage			
	On protected area	On unprotected area	Total	Per cent	On protected area	On unprotected area	Total	Per cent
United States	33,867	57,926	91,793	100.0	$15,048,258	$11,864,037	$26,912,295	100.0
Northeastern	6,251		6,251	6.8	1,903,983		1,903,983	7.1
Appalachian	4,760	67	4,827	5.3	2,160,770	247,094	2,407,864	8.9
Southeastern	5,244	48,956	54,200	59.0	1,469,431	9,771,441	11,240,872	41.8
East Mississippi	909	838	1,747	1.9	266,110	198,328	464,438	1.7
West Mississippi	2,656	8,001	10,657	11.6	74,513	1,528,685	1,603,198	6.0
Lake	3,326		3,326	3.6	980,526		980,526	3.6
Rocky Mountain	3,911	32	3,943	4.3	4,981,648	12,245	4,993,893	18.6
Pacific	6,810	32	6,842	7.5	3,211,277	106,244	3,317,521	12.3

AREA, IN ACRES, BURNED

Group of States [1]	On protected area						On unprotected area	Grand total	Per cent
	Forest land			Non-forest land	Total	Per cent			
	Merchantable or mature tree growth	Unmerchantable or immature tree growth	No tree growth at present						
United States	1,039,571	1,681,760	1,394,445	638,853	4,754,629	100.0	19,561,504	24,316,133	100.0
Northeastern	51,154	112,452	33,858	14,153	211,617	4.4		211,617	.9
Appalachian	106,461	200,000	129,124	12,763	448,348	9.4	55,285	503,633	2.1
Southeastern	206,498	492,938	80,685	30,343	810,464	17.0	17,438,956	18,249,420	75.1
East Mississippi	25,071	88,071	3,143	246	116,531	2.5	62,595	179,126	.7
West Mississippi	39,853	66,188	62,887	5,122	174,050	3.7	1,731,032	1,905,082	7.8
Lake	5,314	345,386	314,286	118,694	783,680	16.5		783,680	3.2
Rocky Mountain	188,732	186,698	182,711	42,061	600,202	12.6	136,636	736,838	3.0
Pacific	416,488	190,027	587,751	415,471	1,609,737	33.9	137,000	1,746,737	7.2

[1] Northeastern group—New England States, New York, and New Jersey.
Appalachian group—Pennsylvania, Delaware, Maryland, Virginia, and West Virginia.
Southeastern group—North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi.
East Mississippi group—Ohio, Indiana, Illinois, Kentucky, and Tennessee.
West Mississippi group—Missouri, Arkansas, Oklahoma, Louisiana, and Texas.
Lake group—Michigan, Wisconsin, and Minnesota.
Rocky Mountain group—Montana, Idaho, Wyoming, South Dakota, Nebraska, Colorado, Arizona, New Mexico, Nevada, and Utah.
Pacific group—Washington, Oregon, and California.

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COOPERATION WITH THE STATES IN TREE PLANTING

Twenty-five million young forest trees from the nurseries of the States cooperating under section 4 of the Clarke-McNary law were distributed to farmers during the year. The charge for the trees varied between the mere cost of packing and shipping and the cost of production. Through the use of this planting stock and trees purchased from private sources, about 30,000 acres of farm land were put on a timber-producing basis—still a negligible part of the total of idle farm lands which could be producing timber. Thirty-two States and the Territories of Hawaii and Porto Rico cooperated. Fourteen of these States did not furnish planting stock prior to the enactment of the Clarke-McNary law in 1924. Many of the States are materially enlarging their nurseries to meet the rapidly increasing demand for trees. New York led in this respect. Its nurseries will produce over 30,000,000 trees next year, of which not less than half will be used by farmers. Other States which are developing nurseries on a large scale are Pennsylvania, Ohio, Massachusetts, New Hampshire, Vermont, Connecticut, Michigan, and Wisconsin. Even in the Inland Empire, on the west coast, and in the South, where timber supplies are less depleted than in the East, the States recognize the need for assisting farmers in this work. One new State, Montana, was added to the list of cooperators, and Mississippi, Illinois, and Tennessee have requested aid under this section of the law.

The allotments made to the States cooperating and their expenditures are shown in Table 1.

COOPERATION WITH THE STATES IN FARM-FORESTRY EXTENSION

Section 5 of the Clarke-McNary law authorizes assistance to farmers in the practice of forestry. The assistance is confined to education and demonstration as contrasted with the distribution of forest trees under section 4 and is given mainly through the State extension organizations created in conformity with the Smith-Lever law. The Federal part of the work is conducted by the Extension Service of the department in cooperation with the Forest Service.

As can readily be seen, this cooperation with the States under section 5 harmonizes with that under section 4, while both are encouraged and stimulated through the cooperation in forest-fire protection which is offered under section 2. During the year five new States included forestry in their extension programs and employed extension foresters, bringing the total number to 30. The Federal appropriation available was $50,000, most of which was used for the employment of extension foresters.

The major activities were forest planting, windbreak or shelter-belt planting, woodland management, timber estimating, and forest protection. Forest planting on land not needed for agricultural crops continued to hold the lead. During the calendar year 1926 there were reported 3,872 planting demonstrations, involving 23,422 acres; and the planting record last spring exceeded that of 1926. The States of greatest accomplishment are naturally those where the State forester has developed a large State nursery and an effective plan for the distribution of tree stock.

Closely akin to forest planting for timber crops is the establishment of windbreaks to protect farm buildings, yards, or field crops. The Middle Western States showed the greatest activity in this direction. Nearly all the cooperating States also reported projects dealing with the care of existing woodlands.

EXPENDITURES AND RECEIPTS

The expenditures for all purposes during the fiscal year were as follows:

General administration	$383,424.23
Protection of the national forests:	
Fire protection and detection	1,723,743.96
Fire suppression	2,772,635.42
Protection against insects and tree diseases	80,807.04
Total	4,577,186.42
Administration of current business on the national forests:	
Administration of timber use	1,136,499.42
Administration of grazing use	926,837.09
Fish and game protection	102,118.15
Administration of recreation and land use	191,074.29
Examination of power sites for Federal Power Commission	17,016.00
Total	2,373,544.95
Surveys of lands and resources:	
General surveys and maps	156,537.30
Grazing reconnaissance	118,242.50
Timber surveys	271,735.18
Total	546,514.98

Land adjustment and extensions:	
Classification, settlement, and claims	$88,309.58
Land exchanges	126,438.41
Acquisition under act of Mar. 1, 1911, as amended	1,001,290.79
Total	1,216,038.78
Nurseries and tree planting	169,262.71
Tree planting in cooperation with States under act of June 7, 1924	71,194.61
Construction and maintenance of improvements:	
Construction of improvements other than roads, trails, and camp-ground improvements	746,625.86
Maintenance of improvements other than roads, trails, and camp-ground improvements	662,425.14
Camp-ground improvements	41,072.00
Total	1,450,123.00
Research:	
Silvical investigations	358,692.44
Forest-products investigations	557,148.28
Range investigations	75,793.31
Taxation study	35,972.24
Total	1,027,606.27
Fire protection in cooperation with States under act of June 7, 1924	667,981.33
Protection of Oregon and California grant lands	77,987.30
Forestry extension	15,293.77
Road and trail construction and maintenance:	
10 per cent fund under act of Mar. 4, 1913	447,852.80
Cooperative construction of roads and trails under act of July 11, 1916	541,804.73
Federal forest-road construction under act of Feb. 28, 1919	57,959.33
Forest development roads and trails under act of Nov. 9, 1921	3,531,934.57
Forest highways under act of Nov. 9, 1921	4,949,201.17
Road and trail construction from moneys contributed by cooperating agencies under act of June 30, 1914, and Mar. 3, 1925	950,554.68
Contributed from other appropriations	456,754.42
Total	10,936,061.70
Grand total	23,512,220.05

The above statement includes not only expenditures made by the Forest Service from congressional appropriations and cooperative funds but also expenditures made by the Bureau of Public Roads for the construction and maintenance of national-forest roads.

In addition to the expenditure for land extension itemized above in the entries "land exchanges" and "acquisition under act of March 1, 1911," national-forest timber having an estimated value of $228,318 was cut under agreements involving the acquisition of land and timber through exchange. The cash disbursements recorded under "land exchanges" cover merely the outlay incidental to examining lands offered for exchange and appraising the values involved.

The grand total shown above is $782,876.85 greater than last year's. Of this increase, more than $172,000 was derived from outside funds contributed for various kinds of cooperative work exclusive of road building. The agricultural appropriation act provided increases of $24,100 for national-forest administration, $67,980 for research, and $75,000 for cooperation with States in fire protection and tree planting. The national-forest fire-fighting funds were greater by $1,450,000, and a special fund of $100,000 was provided for protective improvements in southern California. On the other hand, decreased appropriations available for roads and trails cut down the expenditures for this purpose by more than $1,100,000.

Many of the individual expenditures shown above vary from those reported last year because of a change in the cost-accounting system. Costs are kept on the basis of activities, and to the "productive activities" are apportioned many expenditures for field and office supplies, functions of service, supervision, and the like. The prorating of these costs has in the past been in accordance with the relative money expenditures immediately chargeable to each "productive activity." In the present statement they are prorated according to relative time expenditures. This method affords a fairer picture of relative costs than the earlier method. Its most outstanding results appear in a lessened apparent expenditure on roads and trails under the final item "contributed from other appropriations" of more than $900,000. This decrease is offset by various increases elsewhere, mainly in national-forest administration and protection.

A new item is "forestry extension," which represents educational activities of the forest force not directly contributory to national-forest administration and protection. It is exclusive of cooperative extension work, which is charged elsewhere.

The cash receipts from the national forests were as follows:

From the use of timber	$3,253,242.50
From the use of forage	1,530,952.46
From miscellaneous uses, including the use of land, water-power sites, etc	382,410.78
Total	5,166,605.74

The total is greater by $10,944.72 than that for the previous year. Receipts from timber decreased $113,442.86. Grazing receipts were greater by $109,363.76 and miscellaneous use receipts by $15,023.82.

In addition to the cash receipts from timber there should be credited the value of the timber cut under specific agreements for effecting land exchanges, estimated at $228,318.

NATIONAL-FOREST ADMINISTRATION

It is natural for those interested in the national forests to think of them in terms of a particular form of use or service. Foresters and lumbermen think chiefly of timber growing and harvesting. Stockmen think of forage utilization, and are inclined to question forms of use or development like recreation and game conservation, which may curtail the grazing of domestic livestock. Water users expect this form of service to govern. Automobile tourists want the national forests widely "opened up" with highways, and question timber cutting and other commercial developments which mar their enjoyment of public playgrounds. Other groups think of game conservation and opportunities for the wilderness type of recreation, and are against road building, hydroelectric and other water developments, timber harvesting, and grazing which would impair this form of use. The increasing pressure which results from these diverse views emphasizes the growing need for a sound correlation of land-management policies and expert planning to make the forests serve a wide variety of purposes most advantageously.

Legislation had defined as the purposes of establishing the national forests the continuous production of timber for the use and necessities of citizens of the United States and the preservation of favorable conditions of water flow. Legislation has also given the Secretary of Agriculture broad authority to regulate the use and occupancy of the national forests. These laws must be interpreted and applied to bring about the maximum of public service. The first necessity is to protect the forests from fire and other destructive agencies. This to some degree necessitates either the curtailment of hazardous forms of use or delay in types of development that will ultimately be desirable.

Another basic starting point is that the use of range or timber can not be permitted to injure water resources or accelerate soil erosion.

On certain of the forests an acceleration of erosion with resulting silting of stream channels and irrigation reservoirs appears to be in progress. Special study is being given to determining how far this erosion is influenced by current grazing and other uses of the watersheds and what forms of special administrative control are needed to afford the most complete protection possible. The use of streams within national forests for municipal water supply is widespread; and many cities and towns are seeking special forms of protection on such watersheds, including the elimination of private land holdings and frequently the curtailment of grazing. The safeguarding of municipal water sources is regarded by the Forest Service as the paramount consideration in dealing with any area subject to this form of use; and the handling of timber cuttings, grazing, and recreation is being adapted accordingly. In this respect more complete legislative authority in regard to the operation of certain public-land laws is needed to permit forms of municipal watershed protection not now possible.

It is also a basic principle with the Forest Service that while the use of forage is one of the major forms of economic service to be provided and can for the most part be a continuing and permanent one, grazing can not be permitted to destroy or retard reforestation. This problem has critical aspects at a few points, particularly in the Southwest, where it appears probable that past grazing use has materially interfered with the establishment of pine reproduction. An aggressive attack has been made on this problem through the curtailment of grazing, the segregation of sheep and cattle ranges where dual use was formerly allowed, and the construction of range improvements which will exclude unpermitted livestock and permit much closer control of the use of the range. In this region, for example, grazing is now commonly excluded from pine areas for a considerable period of years in advance of the cutting of mature timber, in order to

encourage the establishment of young growth.

One of the knottiest problems encountered in the correlation of different uses has to do with the various kinds of outdoor recreation. Summer recreationists of all descriptions and tastes are overflowing the national forests in increasing numbers every summer. It is a wholesome and desirable use of public lands, with large social returns. A large majority of the recreation users travel by motor and want good roads, wayside camp grounds, and the public conveniences and utilities that are the usual accompaniments of this type of travel. In many instances this form of use requires not only the extension of camping facilities under safe conditions as to fire hazard but the exclusion of logging, grazing, or other commercial developments from roadside strips of timber, camp grounds, and other areas widely used for recreation. The Forest Service believes that such adjustments should be made and that certain sacrifices in the benefits derived from economic resources are warranted by the benefits derived from public recreation.

Other recreation and conservation groups wish to see large portions of the national forests withheld from road building and the structures and utilities which go with roads, and from any commercial use of timber, water, or forage, and kept as game country and wilderness spaces for the distinctive type of public service that areas left in their natural condition can render. Not infrequently this conception of recreation clashes not only with commercial developments but with motorized forms of recreation.

The Forest Service believes that this again is a matter of correlation, that within reason both forms of recreation can and should be provided in the national forests, and that far-sighted planning is necessary to assure both in fair proportion. The most immediate aspect of this problem has to do with the building of roads which are not required for the protection of the national forests or their economic development but would serve primarily to extend motorized recreation. What the future may bring forth as to the ultimate needs for timber and water and minerals in the present undeveloped hinterland of many national forests can not now be foreseen and must remain a question to be dealt with as such future requirements unfold. The building of what would be primarily recreation roads is, however, an immediate problem on many national forests. While each case must be decided on its merits, the Forest Service believes it to be in the public interest to retain a substantial number of large roadless areas within which some of the most attractive, rugged, and inspiring sections of our mountain country will remain for at least a long time in substantially their natural condition. Such a viewpoint has in mind not only economy in public expenditures for road building and maintenance but the retention of some undeveloped country for its social service through wilderness forms of recreation.

All of these complex and localized problems of land management can not be handled in a practical way on the widely scattered national forests without a large degree of decentralization in their administration. The administration of each national forest must be responsive to local conditions; it must be constructive, vigorous, and prompt to act within the limits of general policies without awaiting the slow process of reference to a central office. The infinite variations in local requirements can be satisfactorily correlated and promptly met only to the degree that the local forest rangers, supervisors, and district foresters are competent, imbued with zest and enthusiasm for their work, and vested with ample latitude within which to employ their initiative and judgment. The Forest Service takes pride in the zeal for public service which characterizes its far-flung organization. To develop this spirit of interested devotion to the efficient management of great public properties is the main purpose of its scheme of organization.

Decentralized management of the national forests does not mean lack of control in essential policies; it means rather an intelligent adaptation of the policy or plan to the immediate facts dealt with in a vast business under an immense range of local conditions. The central office of the Forest Service can and does develop policies, plans, inspection, and means of determining how accomplishment compares with the standards or ideals set up. It supplies advice, general leadership, and the dissemination of knowledge of best practices. It must concern itself no less with the encouragement of incentive, interest, and initiative and with the balance which must be reached between standard practices and the freedom of the individual forest officer to get results. It must concern itself with all possible means of upholding morale and bettering the training of the field personnel. Its

objective, as a necessary phase in the correlation of varied uses, is to develop on the national forests a corps of efficient local administrators trained in productive land management, imbued with the policies and aims of the Forest Service, and intrusted with the authority and responsibility requisite to handle their own problems on the ground with a minimum of long-range supervision.

NATIONAL FOREST PROPERTIES

At the close of the fiscal year the net area of the national forests was 158,800,424 acres; the gross area, inclusive of all private and State-owned land within the boundaries, 183,938,106 acres. The net area increased 41,214 acres; the gross area decreased 185,845 acres.

Of the decrease in gross area 119,705 acres was due to recomputations based on better surveys and land data. Acts of Congress transferred to the Grand Canyon National Park 45,038 acres from the Kaibab and 7,100 acres from the Tusayan National Forest; and to the Sequoia National Park 113,562 acres from the Inyo and 121,318 acres from the Sequoia National Forest. Selections by the States of Idaho, Montana, and Washington in further consummation of land exchanges aggregated 34,325 acres. The abolition of the Upton National Forest because of other disposal by the War Department cut out 6,154 acres. Eliminations by proclamation or Executive order totaled 531,263 acres; the most important were 114,010 acres from the Florida, 46,127 acres from the Kaniksu, 170,200 acres from the Shenandoah, and 193,600 acres from the Unaka National Forest, comprising private lands found not to be purchasable or chiefly valuable for national-forest purposes.

Acts of Congress transferred 11,776 acres from the Sequoia National Park to the Sequoia National Forest, and 24,571 acres from the Grand Canyon National Park to the Tusayan National Forest. Executive orders and proclamations added 743,415 acres. The most important were 385,607 acres added to the Superior National Forest in Minnesota, 191,800 acres to the Unaka National Forest in Virginia and Tennessee, and 97,342 acres to the Ouachita National Forest in Arkansas. These lands were largely privately owned and were added to facilitate their purchase under the Weeks law. Finally, Congress added 2,851 acres to the Colville National Forest in Washington and 9,367 acres to the Shoshone National Forest in Wyoming, following executive action under the Clarke-McNary law in respect to the classification of public lands chiefly valuable for stream-flow protection or timber production.

There are now before Congress other findings of the National Forest Reservation Commission which contemplate 10 further additions to national forests from the public domain. Detailed reports have been prepared upon 35 other areas, comprising in all 1,556,544 acres of unreserved public land, of which approximately five-sixths is timberland or woodland with a total estimated stand of 2,250,000,000 board-feet. These areas will be brought before the commission for consideration in the near future. They are lands which have no value for agriculture, and their value for grazing is subordinate to that for timber production but would be conserved and realized under national-forest administration. Practically all of them are situated within important drainage basins, and they can be administered and protected as parts of existing national forests at a minimum of expense.

PROGRESS IN LAND EXCHANGES

No land exchanges with States were completed during the year, but Michigan, Montana, Oregon, and Washington either have filed or soon will file their final lists of selected lands. Negotiations are in progress with California and Colorado. The exchange authorized with New Mexico as reported last year has not advanced beyond the stage of preliminary discussion.

The only new legislation relative to exchanges passed by Congress was an act bringing within the scope of the general exchange law all lands within 5 miles of the Black Hills and Harney National Forests in South Dakota and Wyoming.

Through 68 private land exchanges the United States acquired during the calendar year 1926, 65,582 acres in return for 23,768 acres of national-forest land and $86,041 worth of stumpage. Thus the net national-forest area was increased by 41,814 acres. Since land exchanges began 153 have been consummated, 248,165 acres of land have been acquired, 100,202 acres of land and $339,406 worth of national-forest stumpage have been granted,

and the net increase of national-forest area has been 147,963 acres. Much of the acquired land bears mature timber which will eventually be sold and thus correspondingly offset the initial grants of stumpage.

Including the value of both land and stumpage granted in 1926, the 65,582 acres acquired was obtained for the equivalent of $3.17 per acre.

The Secretary of Agriculture approved and referred to the Secretary of the Interior during the calendar year 1926, 97 cases contemplating the acquisition of 135,891 acres of private land in exchange for 6,101 acres of national-forest land and 289,000,000 board-feet in stumpage.

Land prices are becoming stabilized and there is every reason to believe that the consolidation of the national forests through private land exchanges can gradually be accomplished with a moderate annual use of forest resources. The land exchange acts place no restrictions on the quantity of national-forest land or stumpage which may be employed for making exchanges, but as a safeguard against too great a use of national-forest resources for these purposes, the Forest Service limits the value of the stumpage to be thus used to 10 per cent of the gross receipts in any State during a single year, and ordinarily to 10 per cent of the timber-sale receipts alone. In the majority of the Western States the land offered now equals or exceeds what this limit allows to be immediately acquired. There will be an increasing opportunity to add desirable private lands to the national forests.

PROGRESS IN LAND PURCHASES

Title was taken under the Weeks law to 176,088 acres at an average cost of $4.93 per acre, or a total of $868,940.45. The average cost was identical with the average for all lands acquired in previous years. The National Forest Reservation Commission authorized purchases totaling 135,088 acres, with an obligation of $725,731.97, or $5.37 per acre.

The distribution by States of the lands fully acquired under the Weeks law is shown in Table 3.

TABLE 3.—*Acreage of timberland acquired in the fiscal year 1927 and total acquired to July 1, 1927, by States.*

State	Acquired, 1927	Average price per acre, 1927	Total acquired to July 1, 1927
	Acres		*Acres*
Alabama	1,854.83	$4.98	89,640
Arkansas	12,796.36	2.91	77,688
Georgia	34,966.04	3.90	194,945
Maine			32,256
Michigan			
Minnesota			
New Hampshire	18,375.95	13.10	427,325
North Carolina	151.38	4.42	364,814
Pennsylvania	65,276.46	4.21	214,506
South Carolina	3,166.10	6.11	41,042
Tennessee	26,711.93	3.66	322,790
Virginia	10,191.62	4.15	574,285
West Virginia	2,596.95	4.26	225,328
Total or average	176,087.62	4.93	2,564,619

The total cost of lands fully acquired has been $12,648,365.63.

No new purchase units were created, but a number of changes were made in the boundaries of units already established. The White Top unit was consolidated with a part of the Unaka unit, while 128,698 acres of the latter unit was made the French Broad division of the Pisgah unit. The boundary of the new Unaka unit was modified so as to exclude certain agricultural lands and to include certain forested lands needed to round out the national forest, making the present area of this unit 625,700 acres—a net decrease of 85,171 acres.

The Shenandoah, Massanutten, and Potomac units in Virginia and West Virginia were combined as the Shenandoah, and the boundaries were revised to exclude considerable agricultural land and to add certain forested areas of which much has already been approved for purchase. The new unit contains 802,700 acres, an increase of 46,186 acres over the old area. From the Monongahela unit approximately 80.000 acres were eliminated while approximately 86,000 acres were added, making the new area 740,462 acres. The Georgia unit was extended southward to take in approximately 60,000

acres, much of which has been approved for purchase by the National Forest Reservation Commission; in consequence the new area is approximately 405,866 acres.

The present purchase areas contain approximately 11,442,676 acres, including two units in the Lake States. They include 1,866,190 acres reserved from the public domain, 11,369 acres transferred from the Treasury Department under a special act, and 2,892,741 acres acquired or in process of acquisition under the Weeks law. Of the remaining 6,672,376 acres, 926,841 acres are known to possess agricultural, mineral, or water-power values which preclude purchase. The net unacquired forest lands in the existing purchase areas is therefore 5,745,535 acres. Some of it is held at prohibitive prices by the owners and some of it is already receiving such care and protection that there is no strong reason for public ownership. Approximately 380,000 acres are now under stable private management.

SPECIAL USES

At the close of the calendar year 1926, 33,065 special-use permits were in force, of which 18,237 were paid and 14,828 were issued without charge. The number of paid permits was 2,024 greater than in the preceding year and the number of free permits 241 greater. The total receipts were $245,464—an apparent decrease of $18,727 from the preceding year.

CLAIMS AND SETTLEMENT

During the calendar year 1926 the Forest Service submitted 265 favorable reports and 23 unfavorable reports on homestead entries and 136 favorable and 38 unfavorable reports on mineral entries. Patents were issued for 330 homestead entries and 266 mineral entries within the national forests, while 60 homestead entries and 29 mineral entries were canceled or rejected.

The twentieth year of the operation of the forest homestead law came to an end on June 11, 1926. The number of applications received during the year for the listing of land or for corrections in the classification previously made was negligible, proof in itself of the thoroughness with which the lands were classified. There were, however, many recalls of listings erroneously made in earlier years. Some such lists, after being open to entry for from 5 to 15 years, were still unentered when recalled. Others had been entered and abandoned by from two to four successive entrymen. The large number of unentered or abandoned listings indicates the liberality with which lands were classified as agricultural.

The fact that national-forest lands are open to unrestricted appropriation under the mining laws causes many administrative difficulties and complications. So far as the prospector and mineral developer are concerned, the creation of national forests was a help and not a hindrance, for thereby mineral lands which otherwise would have become private property were retained in public ownership and kept open for prospecting and patenting. Appreciating as it does the very great importance of the mineral resources within the national forests and the desirability of their development, the Forest Service has consistently endeavored to promote legitimate mining and to cooperate with the men engaged in it. By agreement with the Department of the Interior, all examinations of and reports upon mineral entries within the national forests are made by the Forest Service, and in the performance of this duty the validity of the entries has been ascertained and reported on the basis of their conformity with the mining laws, not on the basis of the national-forest values involved.

The location and entry of mineral lands within national forests by bona fide prospectors and mineral developers is entirely in harmony with the use and management of the forests for other purposes. Unfortunately there is another and totally different class of would-be users of the mining laws who are seeking in increasing numbers by means of these laws to acquire very valuable national-forest lands for purposes entirely unrelated to mining. At present stumpage prices, timber values of from $50 to $100 per acre are not uncommon, and key tracts of national-forest land sometimes are worth from $1,000 to $2,500 per acre for business or recreational purposes or to control resources on large adjoining areas. Sites valuable for water-power production frequently command high prices. These attempts to get land of great market and public value through misuse of the mining laws are of great concern to the Forest Service. To safeguard the public properties, heavy outlays of time and money must be made for the examination of patently fraudulent claims and to secure their cancellation. Some remedial action is imperative. Proposals to that end were submitted to

Congress jointly by the Departments of the Interior and of Agriculture last year. Prevention of the misuse and abuse of the mining laws is fully as important to the organized mining interests as it is to the officers of the Government, and it is hoped and anticipated that their cooperation in the determination of some equitable means of meeting the situation may be obtained in the near future.

COORDINATION OF NATIONAL PARKS AND NATIONAL FORESTS

During 1926 the coordinating committee on national parks and national forests made field examinations of proposed additions of national-forest lands to the Yosemite National Park in California and the Crater Lake National Park in Oregon. The preparation of the committee's reports on the proposed changes in the boundaries of these national parks largely completes its action upon the questions pending before it.

NORTHERN PACIFIC LAND GRANT HEARINGS

Upon the adjournment on June 29, 1926, of the joint congressional committee investigating the Northern Pacific Railway land grants, the representatives of the Northern Pacific and the Forest Service were requested to digest and summarize the various points covered by the 5,000 pages of testimony.

Upon a review of these digests, the joint committee decided, on account of the complexity of the questions involved, that Congress should have the advice of the Attorney General. Thereupon joint resolution of March 3, 1927 (44 Stat. 1405), extended until June 1, 1928, the inhibition against the further issuance of patents to the Northern Pacific, and directed the Attorney General to advise Congress "as to what legal or legislative action should, in his judgment, be taken in the matter of the adjustment of the said Northern Pacific land grants." The case is now being reviewed by the Attorney General.

PROTECTION FROM FIRE

The number, size, and causes of fires on the national forests in the calendar year 1926, as compared with those of the previous year and the average of the past five-year period, are shown in Table 4.

TABLE 4.—*Comparison of fires on national forests, calendar years 1926, 1925, and five-year average for period 1922–1926*

Classes and causes of fires	Number of fires			Percentage of total		
	1926	1925	Average, 1922–1926	1926	1925	Average, 1922–1926
Class of fire:						
Burns less than 0.25 acre	3,590	4,531	3,492	50.60	54.83	49.67
Burns between 0.25 and 10 acres	2,042	2,264	1,985	28.78	27.40	28.24
Burns 10 acres and over	1,463	1,468	1,553	20.62	17.77	22.09
Total	7,095	8,263	7,030	100.00	100.00	100.00
Causes of fires:						
Railroads	390	274	335	5.50	3.32	4.76
Lightning	3,387	5,001	3,237	47.74	60.52	46.05
Incendiarism	661	894	901	9.31	10.82	12.82
Brush burning	255	214	240	3.59	2.59	3.41
Lumbering	119	150	157	1.68	1.81	2.23
Camp fires	672	664	719	9.47	8.04	10.23
Smokers	1,282	843	1,129	18.07	10.20	16.06
Miscellaneous	329	223	312	4.64	2.70	4.44
Total	7,095	8,263	7,030	100.00	100.00	100.00

Calendar year	Total area of national forest land burned over	Total damage of national forest land burned over	Total cost fighting fires exclusive of time of forest officers
	Acres	*Dollars*	*Dollars*
1926	776,570	4,563,081	2,167,732
1925	251,102	752,851	857,516
5-year average, 1922–1926	453,356	1,504,708	1,098,368

The number of fires in the calendar year 1926 was 14 per cent less than in 1925, but the area burned was three times and the damage to national-forest land six times as large.

The reduction in number was chiefly due to fewer lightning fires. The increase in area burned and damage done was due to an unprecedented concentration of lightning fires in time and place, to extreme drouth during the season and the cumulative effect of the deficiency of precipitation during several previous years, and to inability of the organization in certain regions to cope with the severe conditions imposed upon it. More lightning fires were set on a single national forest by a single electrical storm than ever before since these areas were placed under organized protection.

The extent of the losses during the last calendar year called forth special effort to strengthen the defense. Throughout the fall and winter administrative officers in the regions affected gave much time to the study of ways to improve the organization for fire control. During the spring of 1927 the Forester personally reviewed the plans for the coming season on the ground in the four national-forest districts where serious losses had occurred. The experience and judgment of many field men were obtained, and the whole fire problem reanalyzed in the light of the previous year's record.

The season of 1926 strongly emphasized the lesson taught by previous years that catching fires small is the only way to prevent an unmanageable situation and heavy losses. But the number of fire guards which could be employed from the funds available for the season of 1927 was obviously inadequate to cope with the peak load of lightning fires possible on any one of 35 or 40 national forests especially exposed to lightning attack. Nor could the labor supply of cities where drifting labor congregates be depended upon for a quick supply of fire fighters, because too much time is required to mobilize and transport them to inaccessible points. It appeared, however, that more effective use could be made of the crews working on trail and road construction. These crews have always been of great value in fire fighting; but by carefully adjusting the periods of employment on such work to the periods of greatest fire danger and by giving special training for fire fighting to the men, it was found possible to materially increase their effectiveness as a reserve corps of fire fighters.

Speed in surrounding a forest fire with a control line is as important as speed in reaching it. A control line is simply a cleared way, of varying width, through the timber, undergrowth, and fallen logs, with a narrow trench to mineral soil. The control line is widened by setting back-fires which spread from the trench toward the main blaze, thus increasing the chance to hold it. In heavily timbered regions it often requires from 50 to 100 men to construct 1 mile of such a fire barrier in a day, and when weather conditions are adverse or incorrect tactics have been used, the control line so laboriously constructed may easily be lost. During 1925 and 1926 it was discovered that by using a special kind of plow with a heavy horse the trenching operation could be hastened to an extent never before believed possible. A considerable number of these outfits were provided for use in 1927 as a mechanical substitute for hand labor on large fires.

Another matter emphasized by the experience of 1926 was the importance of carefully training fire guards and all other employees who can be used on fires. Some of the worst losses were due to the inability of men to find fires while they were still small. Smoke may be seen a long distance where the view is unobstructed, but when it is in dense timber and broken mountain topography a knowledge of the region and proficiency as a woodsman, as well as determination and endurance, are needed if the guard is to find his fire in time. In planning for the season of 1927, provision was made for longer and more careful training of the guard force than ever before.

When all plans had been made for the best use of available funds and equipment it was still evident that the resources were inadequate to provide against another season such as 1926. Just criticism has been leveled at the fact that whereas no expense is spared to stop fires on national forests after they become large, the expenditures to prevent them or keep them from growing large are insufficient. In the judgment of the best informed and most experienced officers, the cost of fuller preparedness to catch fires small would be much more than made up in the lessened cost of fire fighting, quite aside from the saving in devastation caused by large fires. The Forester therefore authorized expenditures during the season for needed guards,

rangers, equipment, and other forms of preparedness from the appropriation for fighting forest fires, which has been drawn upon heretofore only for fire fighting and the employment of emergency guards when conditions have become acute. It was believed that the total demand on this appropriation would be less if it were used more largely for the prevention rather than the cure of big fires.

THE FIRE SEASON OF THE SUMMER OF 1927

Favorable weather in the regions which ordinarily suffer most from forest fires delayed the opening of the fire season of 1927 well beyond the usual time. Other regions were not so fortunate. In the Southwest, where spring comes early, and also in the Southern States, considerable difficulty was experienced. The southwestern district had only slightly more than half as many fires as in 1926, but the area burned was over four times as great. On the Nebraska National Forest late in the spring 23,000 acres were burned over, and a severe spring drought in the States east of the Mississippi River and south of Virginia resulted in large fires on the Alabama-Benning and Florida National Forests.

In the Pacific and Northwestern States the fires before the middle of July were small and few. In California the damage was slight until the end of July, but on July 29 lightning storms caused more than 100 fires on the Klamath, Shasta, Trinity, and Lassen National Forests in the northern part of the State. By the middle of August the area burned in and adjoining the national forests in California had mounted to 43,550 acres, of which 15,000 acres was within the forests. In the North Pacific States the same electrical storm resulted in severe losses. In Oregon and Washington many lightning fires occurred, with an unprecedented number on the Columbia National Forest, and by August 20 the area burned in national forest and near-by territory totaled 71,900 acres, of which 44 per cent was within the forests.

In the northern district, which comprises Montana and the Panhandle of Idaho, the fire losses are usually greater than in any other district. Here plentiful rains throughout the spring and summer made the task of suppression comparatively easy. The losses were negligible; although there were approximately four-fifths as many fires as in the previous year, less than 0.6 per cent as large an acreage was burned over. While the task of protection throughout the season was incomparably lighter than in 1926, the earnestness of the organization and the benefit of the hard lessons then learned were manifested in a speed and vigor of action unparalleled before, and it is safe to say that substantial progress in methods of fire control has been achieved.

AIR PATROL

A greater value has been commonly attributed to the use of aircraft in fire control than eight years of experience has borne out. It was at first believed that air patrol would afford quicker detection of fires than could lookouts on towers and mountain peaks. This has been disproved. Nor is it surprising that relatively few first reports of fires have come from the aircraft, since any one locality is under observation only a short time during the 24 hours even if two or three patrols are made daily. Continuous observation of the terrain, such as lookout men on towers and mountain peaks have if intervening topography does not cut off a part of their view, is essential to effective fire control.

The use of airplanes after lightning storms to search out smoldering fires which might be hidden from ground lookouts by intervening ridges has as yet given disappointing results, but the possibilities of this use of aircraft have not been exhausted. Airplanes are in use in California, Oregon, Washington, Idaho, and Montana, chiefly to reconnoiter large fires. In certain instances this has proved very helpful. Where there are no ground lookout men, they are valuable also to learn whether any fires are burning and, if so, where located and how large. The difficulty of protecting national forests from fire is such that every promising method must be tried. The Forest Service plans to continue the experimental use of aircraft and thus to determine definitely their place and limitations.

THE FOREST PROTECTION BOARD

The Forest Protection Board, composed of representatives of the National Park Service, the General Land Office, the Bureau of Indian Affairs, the Forest Service, the Bureau of Biological Survey, and the Weather Bureau, was established by the chief coordinator on January 26, 1927. As

stated in the order of the chief coordinator, "The purpose of this board is to formulate and recommend to this office general policies and plans for the protection of the forests of the country, especially in the prevention and suppression of forest fires, embracing measures for the cooperation of Federal, State, and private agencies."

Following a series of 11 meetings, the board presented a report to the chief coordinator which sets forth the action necessary in its judgment to coordinate the protection of the forest lands administered by the several Federal bureaus and to effect more adequate protection of State and private forest lands under the cooperative policy laid down in the Clarke-McNary Act. This is probably the first occasion on which a coordinated picture of the forest-protection problem of all of the lands in the continental United States, under whatever jurisdiction or ownership, has been presented in a single statement.

It is the purpose of the board to continue its collaborations with a view to working out more complete cooperation and coordination in the protective work of the Federal agencies and to make mutually available the results secured in the development of protection methods.

PUBLIC AID IN PROTECTION

The enormous increase in the use of the national forests would make their protection well nigh an impossible task if the Forest Service had to carry the burden unaided. The function of the Forest Service is partly to supply leadership, guidance, and the skeleton organization necessary to enable the public to protect its own property. It makes a great practical difference whether the viewpoint is that the Forest Service is protecting Government property with Government funds or that the Forest Service and the local public are working jointly to protect the forested land on which local prosperity depends. In many regions the local communities have recognized the vital interest they have in the protection of their forests and ranges and have come to take pride in the degree to which they have prevented fires from starting or growing large. The Forest Service aims to develop local public appreciation of what the national forests mean to those living near them, and to encourage local participation, sense of responsibility, and initiative in the prevention and suppression of forest fires.

In inaccessible regions, particularly where lightning fires are troublesome, the Forest Service must maintain a complete organization for the sake of speed in initial action; but even here interest and support by the nearest residents is vital, especially to provide supplementary personnel to support the fighting lines when numerous lightning fires exhaust the capacity of our regular force.

MOST URGENT NEEDS FOR PROTECTION FROM FIRE

As a result of the special study of fire prevention and organization made by the Forester in March, April, and May, 1927, certain conclusions may be set forth as to the measures which are necessary if forest protection is to be sufficiently strengthened to meet the occasional extreme fire years in which the bulk of the fire expeditures and losses occur.

Vigorous development of educational and cooperative measures designed to prevent man-caused fires is urgently needed. Restrictive measures such as closing timbered areas to use or vigorous enforcement of laws pertaining to the use of fire have their place temporarily, and indeed may themselves be made effective educational measures; but the problem is not solved by closing to use areas which play an important part in the social and economic life of the people or by enforcing penalties after losses due to carelessness have occurred. The ignorance and carelessness which cause so large a proportion of the annual fire toll must be dealt with in a constructive way before forest-fire protection will be on a solid foundation. As forest officers and other forest-protection agents meet our farmers, lumbermen, and recreationists face to face, individually or collectively, an increasing appreciation is obtained of what it means to preserve our remaining stands of timber and bring our idle acres of timberland into production. In those relatively few communities where deliberate woods burning has been the custom for generations, individual forest officers properly equipped with mechanical aids have been able to do more in stopping fire losses by explaining the value of reforestation than scores of men could do by fighting incendiary fires.

Fire prevention is basically a matter of changing viewpoints and habits

which have grown up through many years when the supply of timber seemed inexhaustible and the regrowth of timber a thing to be fought in order that land might be used for agriculture and grazing. To accomplish so large an undertaking as the transformation of these viewpoints and habits requires not only the earnest efforts of many men but abundant aids in the shape of printed and other educational matter. The contriving and production of the needed films, posters, and other visual-education material is no small task. It is the settled policy of the Forest Service to work for the prevention of man-caused fires by every available means, particularly through carefully devised plans for dealing with specific local situations where man-caused fires are still serious. A considerable portion of the funds now available are devoted to this activity.

Another conclusion which can not be escaped when a fact-finding survey is made on the ground is that increases are needed in the appropriations for employing guards, buying fire equipment, training fire personnel, and constructing telephone lines, lookout structures, and other improvements essential in fire control. Spending more freely in fighting big fires is worse than locking the barn door after the horse is stolen. It is economical to provide the men, the equipment, and the permanent improvements which will make it possible to cope with forest fires in their initial stages. Preparedness of this kind not only will save larger expenditures for fire fighting but also will prevent the destruction of mature timber and young growth and the conversion of productive forest land into nonproductive wastes or land growing only a partial and inferior timber crop.

A third conclusion is that under American conditions fire control is an important part of technical forestry. It calls for building up and applying specialized knowledge of the physical conditions that create a high fire danger, and still more for developing technical methods and appliances that will facilitate control. These include practicable ways and means of fire-proofing wooded areas and of constructing firebreaks, suitable machinery and equipment for use in the various operations involved, and the perfection of fire-suppression technic in every stage from the initial attack to the final mopping up after the spread of the flames has been stopped.

Similarly, there is need to develop the function of executive management in connection with fire control. The experience of years has proved that the most important of all the factors contributing to effective control is the executive direction exercised by the responsible officer in charge on the ground. The function is essentially the same as in any other large organized effort, but it has not been developed through long use and the accumulated experience of generations, as it has in most fields of business administration. Never before have men been presented with such a forest-fire problem as is confronted in America. Efficient organization and direction of the actual field effort can not be brought about by order or a quick training course. Careful study must be made of the often obscure differences between skillful and unskillful management so that the methods which are most effective may be found and their use made general.

PROTECTION FROM INSECTS

On the national forests the most serious insect menace is bark beetles, which are always at work in coniferous forests and become epidemic when conditions favorable to their multiplication arise. In that case, unless steps are taken to check the increase of the broods, very large quantities of valuable timber may be killed. The larvae of the beetle do the killing. The adult beetle bores through the bark and lays its eggs in the soft pulpy tissue of the living inner bark, or cambium. When the eggs hatch the larvae feed in the cambium. As there are usually many larvae feeding in a tree attacked by the beetles, the effect is the same as girdling the tree.

Control of bark-beetle epidemics is brought about by felling the infested trees and peeling or burning the bark. As a rule epidemics occur in the older and therefore less-resistant stands. Ordinarily if the lumberman does not harvest the ripe timber the beetles will in course of time. Until our susceptible forests are cut over and the ripe timber harvested, a considerable loss from insect depredations will be experienced. Once the forests are placed in a thrifty growing condition, losses caused by insects as well as expenditures for control should materially decrease.

As forecast in last year's report, a large portion of the funds available for insect control was devoted to the Bitterroot-Beaverhead project in Montana. This infestation, which has been active for the last three years, is especially heavy and has spread

over a large territory. It was hoped the funds available for the fiscal year 1927 would be sufficient to clean up the infestation at points where it was likely to spread. Last fall, however, it was found that the spread had been much greater than had been anticipated, so that with the limited funds available it was thought best to concentrate all work on the Big Hole drainage of the Beaverhead National Forest. Control work was also continued on the Kootenai National Forest, another Montana project. Last year's work on this project effected a 38 per cent reduction in the number of trees infested, and the infestation is believed to be under control, but it will require further attention. There are no indications of a recrudescence of the outbreak brought under control two years ago in the Kaibab National Forest, but a close patrol will need to be maintained there for some time.

A serious epidemic in western yellow pine stands on the Colorado National Forest, in the vicinity of the Rocky Mountain National Park, was treated last spring in cooperation with private owners and the National Park Service, and about 2,000 acres of infested lodgepole pine timber on the Crater National Forest, adjacent to the Crater National Park, was also treated. The National Park Service has been fighting this epidemic inside the park boundaries for the past two years, and it became necessary for the Forest Service to carry on work within the Crater National Forest in order to prevent reinfestation of the park timber. In California small control projects were continued in the southern part of the State in cooperation with private owners. A rather serious infestation has occurred in western yellow pine on the south side of the Ashley National Forest in Utah. National-forest and Indian lands are involved. Control work was initiated last spring in cooperation with officials of the Office of Indian Affairs, and about 1,000 trees were treated.

There were numerous other infestations which should have had treatment, but lack of funds made it necessary to restrict control work to the most urgent cases. The failure of the second deficiency appropriation bill last spring necessitated the abandonment of a number of important projects and the curtailment of others.

The Bureau of Entomology continued its very effective cooperation in the prosecution of the various control projects and in furnishing advice and information along entomological lines. The bureau has been especially helpful in carrying on cooperative studies of cut-over sale areas for the purpose of determining the classes of trees which if reserved from cutting are most susceptible to insect attack.

TIMBER

The cut of timber under commercial and cost sales for the fiscal year totaled the equivalent of 1,170,000,000 board feet. This is some 22,000,000 board feet less than for the previous year. With some fluctuations, the annual cut has been gradually increasing for more than 20 years. The decrease last year was due largely to adverse market conditions in four of the eight national-forest districts.

In addition approximately 83,447,000 board feet was cut under land-exchange agreements, as compared with approximately 36,000,000 feet cut during the preceding year. Including the cutting in satisfaction of land-exchange agreements, the total use of national-forest timber was somewhat greater in 1927 than in 1926.

Increases in timber cut are the result of a normal growth brought about largely by the development of private timber properties, which in turn has made the Government timber more accessible. It is not the policy of the Forest Service to force its timber on the market, and sales are made only after careful consideration of the necessary balance between milling capacity and the growth of the timber and the part the Government timber should play in local economic development.

As extensive liquidations of private timber investments in the Pacific Northwest, through manufacture, have been necessary during recent years, the question is occasionally raised as to the soundness of the Forest Service policy governing the sale of national-forest timber in that region. The contention is made that the Forest Service in placing large tracts of timber on the market is competing with owners of private timber who must cut to reduce their investments and carrying charges and is accentuating the tendency toward overproduction of lumber and wasteful use of a natural resource.

Sales of national-forest timber have not been a material factor in the conditions controlling the production and value of lumber. Large sales of national-forest timber are made (1) to enable established mills to continue in operation, thus stabilizing the communities dependent on those mills for employment; (2) to prevent the depreciation in value of Government

timber which should be logged with privately owned intermingled timber that is being cut; (3) to aid in the development of regions or communities by the establishment of industries and transportation facilities; and (4) to harvest deteriorating timber before its value is lost to the owners, the people of the United States.

That the policy has been one of conservative development rather than of forcing the exploitation of the national forests is indicated by the fact that the annual cut of timber has increased but 178,000,000 board feet during the last five years, that it is still but one-sixth or less of the annual yield which the national forests could maintain in perpetuity, and that, although the national forests contain a fourth of the standing timber in the United States, they now furnish less than 2 per cent of the current production of lumber.

During the year an established operator was sold 62,000,000 board feet on the Harney National Forest; a sale of 154,000,000 board feet was made on the Stanislaus National Forest to an established operator whose improvements, constructed to remove his own timber, opened up adjacent Government areas; 270,500,000 board feet on the Sierra National Forest was advertised and sold to an operator whose private holdings were intermingled with Government timber; 92,000,000 board feet on the Olympic National Forest was advertised and sold to a purchaser who desired to operate the Government timber in conjunction with some 200,000,000 board feet of private timber.

The starting of a new crop while harvesting the old is an essential feature of national-forest operations. Due consideration is given in all sales to the relation the proposed cut bears to the predicted growth of the particular unit or working circle from which the timber will be removed. All cutting is done with a sustained yield of timber products as the ultimate goal.

The most notable development in the timber-sales business of the year was the award of two large pulp-wood units in Alaska, aggregating 1,670,000,000 cubic feet. The greatest importance of these awards lies not in the sales themselves but in what they mean to the development of Alaska.

These two units—the Juneau in the northern part and the Ketchikan in the southern part of the Tongass National Forest—were offered for sale after prolonged efforts to give publicity to the proposed sales and to arouse the interest of possible bidders. The units were advertised at a price of 60 cents per 100 cubic feet for spruce pulp wood and 30 cents per 100 cubic feet for hemlock. Two bids were received for the Ketchikan unit and one for the Juneau unit. Each sale contemplates 50 years' supply of pulp wood for a large paper plant, with provision for an adjustment of the price paid the Government at intervals of five years.

These large pulp-wood sales in Alaska represent the culmination of 15 years of work by the Forest Service to get the newsprint industry extended to Alaska. The two big paper mills which will be built will mean much in the economic development of Alaska. Each project will require an investment of at least $8,000,000 or $10,000,000 in water-power development, manufacturing plant, and logging equipment. This primary development, requiring the employment of a large number of men, will inevitably bring about the establishment of other business enterprises. Both awardees are responsible concerns and each has received a power permit from the Federal Power Commission, with two years to qualify for a power license and to complete the preliminary steps for securing a final timber contract.

These two units are but a portion of the available power and timber resources of Alaska. It is estimated that five or six large plants, producing an aggregate of 1,000,000 tons of paper annually, can be maintained in Alaska in perpetuity. The policy of the Forest Service is to encourage the establishment of paper plants in Alaska only to the extent that they will utilize the annual growing capacity of her pulp-wood forests. To each group of water-power sites sufficient areas of timber and timber-growing land have been tentatively allotted to make possible a continuous supply of raw material through natural regeneration following cutting. In planning this permanent development of the paper-making industry in Alaska due provision has been made for holding available the timber areas needed to supply the local markets of Alaska, her fish industries, and her sawmills which are now profitably exporting high-grade lumber.

Considerable criticism of these sales has arisen, particularly in the Pacific Northwest. The economic soundness of making such large tracts of Government timber available at this time

has been questioned. The claim has been made that the Forest Service in placing these enormous virgin tracts of pulp wood on the market is in large measure making impossible the utilization of waste from logging and milling operations in Washington and Oregon, and that the development of the newsprint industry in Alaska should be postponed until the wood waste in lumber operations of the Pacific Northwest is more largely utilized for supplying the wants of the paper industry.

It is not probable that the paper-manufacturing industry anticipated in Alaska will compete seriously with the industry as it is now developing in Oregon and Washington. The spruce and hemlock of Alaska will be used in the large-scale production of newsprint, while the waste from logging camps and sawmills in Washington and Oregon may be utilized for a variety of papers and fiber boards, including newsprint but not as a major product. Generally speaking, the setups as to water power, quantity of raw material, marine transportation, etc., necessary to compete with the offerings in Canada for large-scale newsprint production under present conditions are to be found to a larger degree in Alaska than in the Western States. To-day over 50 per cent of the paper consumed in the United States, or the raw material from which it is manufactured, is imported.

The Forest Service feels a special responsibility to aid in the development of Alaska. It also believes that Alaska should have the opportunity to get this industry now if economic conditions invite it. All of Alaska's more valuable coastal timber has been withdrawn in national forests, and, unlike the situation in our Pacific Coast States, there is no opportunity to create forest industries except by using national-forest resources. The Forest Service has been under fire many times for its policy of forest conservation in Alaska, which many people have regarded as a locking up of resources. It has always pointed out that, when economic conditions permit, Alaska would get her forest industries and get them under a type of development that would make them permanent. Now that the opportunity has arrived, Alaska should be helped rather than hindered in this economic development. Furthermore, as custodian of public property, the Forest Service has a responsibility to bring about the utilization of the immense quantities of mature timber now going to waste in Alaskan forests.

Tables 5, 6, and 7 summarize the national-forest-timber business for the calendar year 1926.

TABLE 5.—*Quantity and value of national-forest timber sold, calendar year 1926*

State	Quantity sold			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	Board feet	*Board feet*	*Board feet*			
Alabama	160,000		160,000	$360		$360
Alaska	32,919,000		32,919,000	51,528		51,528
Arizona	98,416,000	373,000	98,789,000	222,898	$409	223,307
Arkansas	5,500,000	200,000	5,700,000	39,995	200	40,195
California	621,316,000	2,031,000	623,347,000	1,869,304	1,396	1,870,700
Colorado	70,726,000	925,000	71,651,000	198,878	912	199,790
Florida	2,397,000		2,397,000	11,991		11,991
Idaho	156,935,000	4,878,000	161,813,000	373,805	4,510	378,315
Michigan	329,000		329,000	394		394
Minnesota	6,356,000		6,356,000	25,892		25,892
Montana	25,829,000	3,598,000	29,427,000	68,448	3,813	72,261
Nevada	1,112,000	387,000	1,499,000	963	351	1,314
New Hampshire	3,207,000		3,207,000	14,090		14,090
New Mexico	42,416,000	602,000	43,018,000	105,796	523	106,319
North Carolina	11,922,000		11,922,000	30,728		30,728
Oregon	105,328,000	2,228,000	107,556,000	287,125	1,492	288,617
Pennsylvania	4,000		4,000	40		40
South Dakota	73,528,000	726,000	74,254,000	259,987	732	260,719
Tennessee	20,045,000	113,000	20,158,000	28,409	135	28,544
Utah	6,657,000	1,009,000	7,666,000	10,832	1,071	11,903
Virginia	13,828,000	3,000	13,831,000	30,603	6	30,609
Washington	135,454,000	153,000	135,607,000	358,680	93	358,773
West Virginia	692,000	5,000	697,000	1,747	4	1,751
Wyoming	36,115,000	950,000	37,065,000	69,894	878	70,772
Total, 1926	1,471,191,000	18,181,000	1,489,372,000	4,062,387	16,525	[1] 4,078,912
Total, 1925	1,753,077,000	18,454,000	1,771,531,000	4,395,608	15,470	[2] 4,411,078

[1] In addition, minor products not convertible into board feet were sold, value $19,655.
[2] In addition, minor products not convertible into board feet were sold, value $12,146.

TABLE 6.—*Quantity and value of national-forest timber cut under sales, calendar year 1926*

State	Quantity cut			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	Board feet	*Board feet*	*Board feet*			
Alabama	126,000		126,000	$329		$329
Alaska	55,761,000		55,761,000	90,249		90,249
Arizona	28,786,000	359,000	29,145,000	78,031	$343	78,374
Arkansas	18,550,000	102,000	18,652,000	147,270	101	147,371
California	319,362,000	1,955,000	321,317,000	957,009	1,211	958,220
Colorado	40,176,000	802,000	40,978,000	111,495	789	112,284
Florida	1,921,000		1,921,000	10,544		10,544
Idaho	129,961,000	3,514,000	133,475,000	539,110	3,119	542,229
Michigan	526,000		526,000	681		681
Minnesota	8,271,000		8,271,000	32,507		32,507
Montana	28,464,000	3,947,000	32,411,000	67,271	4,220	71,491
Nevada	1,372,000	377,000	1,749,000	1,240	365	1,605
New Hampshire	4,866,000		4,866,000	24,846		24,846
New Mexico	8,625,000	579,000	9,204,000	18,683	487	19,170
North Carolina	5,804,000		5,804,000	18,543		18,543
Oregon	234,432,000	2,229,000	236,661,000	678,528	1,469	679,997
Pennsylvania	300,000		300,000	689		689
South Dakota	23,626,000	724,000	24,350,000	95,055	758	95,813
Tennessee	7,510,000	169,000	7,679,000	16,946	186	17,132
Utah	8,315,000	934,000	9,249,000	13,884	980	14,864
Virginia	9,772,000	25,000	9,797,000	26,232	25	26,257
Washington	181,824,000	181,000	182,005,000	407,280	108	407,388
West Virginia	579,000		579,000	1,632		1,632
Wyoming	39,521,000	926,000	40,447,000	103,083	863	103,946
Total, 1926	1,158,450,000	16,823,000	1,175,273,000[1]	3,441,137	15,024	[1] 3,456,161
Total, 1925	1,167,468,000	15,699,000	1,183,167,000	3,320,963	13,998	[2] 3,334,961

[1] In addition, minor products not convertible into board feet were cut, value $9,526.
[2] In addition, minor products not convertible into board feet were cut, value $4,769.

TABLE 7.—*Number of national-forest timber sales classified according to amounts of sale, calendar year 1926*

State	$500 or under, commercial sales	$500 or under, cost sales	Total	$501 to $1,000	$1,001 to $5,000	Over $5,000	Total
Alabama	31		31				31
Alaska	246		246	7	9	1	263
Arizona	903	240	1,143		2	3	1,148
Arkansas	35	70	105	1		2	108
California	487	367	854	6	12	15	887
Colorado	464	187	651	53	10	7	721
Florida	69		69	1	2		72
Idaho	1,074	1,663	2,737	7	13	8	2,765
Michigan	20		20				20
Minnesota	109		109	22	6		137
Montana	557	946	1,503	8	9	1	1,521
Nevada	85	133	218				218
New Hampshire	175		175	2	4		181
New Mexico	748	360	1,108	3	5	2	1,118
North Carolina	230		230		3	1	234
Oregon	460	451	911	6	8	6	931
Pennsylvania	1		1				1
South Dakota	226	92	318	6	7	3	334
Tennessee	320	50	370	5	6		381
Utah	326	561	887				887
Virginia	522	8	530	1	4	1	536
Washington	139	32	171	4	9	7	191
West Virginia	17	3	20				20
Wyoming	284	206	490	3		1	494
Total, 1926	7,528	5,369	12,897	135	109	58	13,199
Total, 1925	7,525	4,583	12,108	64	105	72	12,349

TIMBER PLANTING

Table 8 shows by States the acreage planted on the national forests for the calendar year 1926.

TABLE 8.—*Planting on national forests by States, calendar year 1926*

State	Area planted
	Acres
Michigan	4,719.60
Washington	1,707.00
Idaho	1,568.00
Colorado	1,252.85
Nebraska	1,136.67
Montana	1,074.00
Minnesota	782.38
North Carolina	125.00
Oregon	125.00
California	50.82
New Jersey	27.50
Virginia	23.50
New Hampshire	18.60
Pennsylvania	4.00
Kentucky	1.00
Total	12,615.92

In addition, one acre in Tennessee was sown with tree seed.

There is a striking contrast between the total of 12,617 acres which was artificially reforested in 1926 and the total acreage of 2,100,000 acres of nonproductive land still in need of planting. The Federal Government is failing to reforest its lands at a reasonable rate. It is lagging behind the efforts of States and even of some private owners in this field. Public criticism of the rate at which the Government is restoring its denuded lands to productiveness, where natural regrowth can not take place in a reasonable period, is well founded. The redwood owners are planting annually more land in California than is being planted on the national forests of California, Washington, and Oregon. The States of New York and Pennsylvania are producing more trees for forest planting in their nurseries than are being produced in all the nurseries of the Forest Service for planting on the national forests. As has been pointed out in previous reports, at the present rate of planting the national forests it would take over 170 years to complete the job.

In planting, priority should be given some 650,000 acres which are of relatively high productviity and accessibility. These lands are in the East (including a number of military reservations which are also national forests), in the Lake States, in the western white pine region of northern Idaho and western Montana, and in the Douglas fir belt of Washington and Oregon.

There are large areas elsewhere which, while not so highly productive, are capable of producing timber of value and the planting of which can be fully justified. In Colorado and Wyoming there is an increasing demand from cities and towns for the planting of watersheds from which municipal supplies are obtained. On the watershed of the city of Denver alone there are 55,000 acres of old burns inside the national-forest boundaries which are not restocking naturally. The city of Cheyenne has repeatedly urged that the Forest Service undertake and push as rapidly as possible planting on portions of the Medicine Bow National Forest from which it draws its municipal supply of water.

For the past 20 years the Forest Service has been carrying on a large afforestation project in the Nebraska National Forest. This project, at first largely experimental, has clearly demonstrated the feasibility of growing forests in Nebraska. There are some 170,000 acres yet to plant, and it is desirable to continue the work at the rate of about 1,200 acres annually. Climatic and labor conditions on the Nebraska forest are adverse to any large increase in the rate of planting, but eventually an important local supply of timber will be provided by this forest.

In northern California there are large brush fields occupying some of the best yellow pine and sugar pine sites. These brush fields are the result of repeated burns, and once established are very difficult to reforest. For some time to come the work of reforesting these areas will be largely experimental. Outside of these brush fields there is a comparatively small acreage which is not restocking.

The estimate of 170 years to complete the present program is in itself misleading, since it is based on the job as it exists to-day and does not take into consideration the acreage which may be added through forest fires and by the acquisition of additional lands. Were the present rate of planting on the national forests only doubled, this would make possible the reforestation of the 650,000 acres of highly productive lands in 25 years, and of some 100,000 acres of the other lands described.

RANGE

GENERAL CONDITIONS

Nothing affects the range livestock industry so much as the weather for the year. Mild or open winters and ample precipitation evenly distributed through the spring and summer are generally regarded as ideal, though winter storms are necessary to provide water for irrigation and to replenish springs and streams on summer range. In the winter of 1925–26 the precipitation in the western range States was scant, though sufficient to assure good feed on the ranges. The stock wintered well on the ranches. A very mild spring with enough moisture to provide good spring feed was followed in Colorado, Wyoming, and eastern Montana by a summer of well-distributed rains and forage conditions above normal. But on the Pacific coast, in the Northwest, and in Utah and Idaho, the summer was one of extreme drought.

In the Southwest, drought had been long continued. The season of 1926 marked its break, and, on the whole, feed conditions were better than for a number of previous years, although still under normal.

Throughout the West an extremely favorable fall was followed by a winter of heavy snows but generally favorable to the livestock industry. The surplus feed carried over from the winter before, with that harvested during the summer of 1926, provided amply for the needs of a rather long feeding period. Large calf and lamb crops resulted from an excellent spring in 1927, and thus far the forage conditions during this year have been more favorable than at any time during the past decade.

The tendency to change from cattle to sheep mentioned in last year's report continued, but it was less pronounced and will probably be materially less during the rest of this year. The Forest Service policy has been to permit this change where the range and general economic conditions justify it. Under this policy the nonuse privilege has been granted extensively to cattle permittees where all indications pointed to their early resumption of range use. Temporarily these ranges were occupied by sheep in a large number of cases. Where ranch properties were dependent upon national forests for range which had been used for cattle grazing and the owners changed permanently to sheep, they were allowed permits for the latter class of stock. Economic conditions must to a large extent determine the policy of the service in this matter.

USE OF THE RANGE

Table 9 shows the number of livestock by classes and the number of permits for use of the national forests during the season of 1926.

TABLE 9.—*Grazing permits issued and number of stock grazed on the national forests, calendar year 1926*

State	Cattle, horses, and swine				Sheep and goats		
	Permits issued	Number of stock grazed			Permits issued	Number of stock grazed	
		Cattle	Horses	Swine		Sheep	Goats
Alabama	3	21					
Alaska	1	11	1			30	
Arizona	1,333	233,546	2,573	271	112	259,725	1,140
Arkansas	19	479	3	38	1		10
California	2,140	163,498	5,992	266	347	421,690	3,197
Colorado	3,143	281,647	5,851		802	955,827	606
Florida	9	317		5	2	455	
Idaho	3,047	132,323	9,607		950	1,303,092	123
Montana	2,111	128,243	10,523		452	566,298	87
Nebraska	38	9,569	649				
Nevada	437	58,891	2,303		109	299,406	
New Hampshire	25	165	16				
New Jersey	2	33					
New Mexico	1,860	92,050	3,073	180	312	210,059	10,390
North Carolina	107	426	42	140	19	211	
Oklahoma	47	2,366	235				
Oregon	1,254	95,292	5,222	10	434	631,283	48
South Dakota	581	22,626	1,691		26	17,458	
Tennessee	16	100			4	52	
Utah	4,768	121,082	4,806	168	1,915	732,663	
Virginia	99	1,021	3		5	127	
Washington	432	13,177	815		138	173,815	65
West Virginia	36	369	21	7	48	1,322	
Wyoming	787	99,606	3,970		306	639,144	
Total, 1926	22,295	1,456,858	57,396	1,085	5,982	6,212,657	15,666
Total, 1925	23,805	1,538,942	57,904	846	5,835	6,162,263	19,795

The number of cattle and horses was 82,592 less and of cattle and horse permits 1,510 less than in 1925, while the sheep and goats increased by 46,265 and the sheep and goat permits increased by 147. The total number of permits was 1,363 less.

Numbers by themselves, however, are misleading. Much of the decrease is only temporary, since the granting of the nonuse privilege for the protection of former permittees has been very general. A careful survey during the past few years has resulted in more accurately establishing the carrying capacity of most of our national-forest ranges. It is believed the figures arrived at are conservative and will hold for the 10-year permit period except in isolated cases. The number of stock actually grazed on the forests during 1926 is approximately 87 per cent of the estimated carrying capacity of the range for cattle and horses and 89 per cent of the capacity for sheep and goats.

The difference between actual use and carrying capacity is due to a number of variable factors, some of which may be attributed to a lack of demand for the more remote and inaccessible sheep ranges. The difference between actual use and permitted numbers is due mostly to permittees being unable to restock to the full amount of their established preferences. It is accounted for by a slightly smaller number per permit, which is not greater than the ordinary fluctuations due to financial, feed, market, and other economic conditions. It is believed that as soon as these conditions adjust themselves the numbers of both stock and permits will become fairly stable.

The changed grazing regulations had a pronounced effect in stabilizing the use of national-forest range, even though the number of permits and numbers of stock have declined.

Table 10 shows the number of term permits and the number of stock covered thereby.

TABLE 10.—*Term or 10-year permits, 1926*

District	Number term permits issued		Number of stock under term permits		Per cent of term permits to total		Per cent of stock to total		Total permits issued		Total stock permitted	
	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats
1	638	130	62,393	241,574	28.9	25.6	42.1	35.7	2,207	507	145,892	677,699
2	864	296	128,023	564,664	19.7	28.4	32.2	39.5	4,376	1,041	397,087	1,428,989
3	1,006	130	159,183	297,360	32.1	30.8	46.5	61.7	3,136	422	342,445	481,684
4	7,143	2,701	299,609	2,421,129	84.7	89.6	79.5	93.0	8,428	3,014	377,184	2,602,485
5	309	88	36,977	115,106	14.4	25.3	21.8	27.6	2,140	347	169,349	417,235
6	139	215	18,427	303,863	8.2	37.6	16.0	37.3	1,686	572	115,439	814,430
Total	10,099	3,560	704,612	3,943,696	45.9	60.3	45.6	61.4	21,973	5,903	1,547,396	6,422,522

Of all permits issued, 45.9 per cent of those for cattle and horses and 60.3 per cent of those for sheep and goats are term permits. Of the total number of stock, 45.6 per cent of the cattle and horses and 61.4 per cent of the sheep and goats are under term permits. Considering that 16 per cent of the sheep and goats and 23 per cent of the cattle and horses are under temporary permit, it appears that term permits have been applied as far and rapidly as conditions justify and the stockman desire them.

GRAZING SEASONS

Experiments and observations extended over a period of 20 years prove conclusively that the regulation of the seasonal use of national-forest range is essential to the proper maintenance of the forage. Premature use, before forage has reached its proper growth, is one of the main causes of overgrazing and range deterioration. In recognition of this principle and the fact that the greatest single factor in stability of range use is a plentiful

and permanent supply of forage, an earnest effort has been made to establish grazing seasons in conformity with the growth requirements of the vegetation. At the same time it has been recognized that adjustments in this respect must proceed in a gradual way, in order that permittees may adjust their business to meet the changes. Often the condition of the range can be improved only by either reducing the number of stock or shortening the grazing season. The former is usually more severe, since a fixed number of stock is necessary to make operation of a ranch profitable. The field officers have been called upon to review this whole question as part of the general program of stabilizing range use.

GRAZING FEES

One of the outstanding features of the past year was the settlement of the grazing-fee question. This was brought about by the Secretary of Agriculture in personal conference with representatives of the two national livestock associations in January, 1927. After meeting with representatives of the stockmen the Forester recommended to the Secretary of Agriculture:

1. That no increases in grazing fees be made during the year 1927.

2. That a schedule of maximum and minimum grazing fees for the respective national forests be approved, based upon the range appraisals of the Forest Service and the recommendations of Dan D. Casement, subject to such reductions as were found equitable to adjust fees fairly between the different national forests and regions, and to other necessary adjustments in establishing equitable fees between the different allotments on each national forest.

3. That the increases in fees called for be applied in installments of 25 per cent each during the years of 1928, 1929, 1930, and 1931, the full increase being applied during the years from 1931 to 1934, inclusive.

4. That in view of the social and economic purposes of the Forest Service in the administration of grazing and the general public benefits derived from the national forests, this schedule of fees be accepted as representing fair compensation for grazing on the respective national forests under present conditions.

5. That no changes in this schedule of grazing fees be made for the 10-year period beginning in 1935 unless there should be a material change in the conditions which affect the elements entering into an equitable determination of fair compensation for grazing on national forests.

These recommendations were approved by the Secretary of Agriculture. Final schedules under this decision are now being worked out by the Forest Service on all national forests. Under the new schedules the average fee for cattle will be increased from 10.4 cents to approximately 14.4 cents per month; and the average fee for sheep from 2.9 to about 4.5 cents.

Since 1921, when Congress authorized the waiving of grazing fees in certain sections of the West, there has been some delinquency in the payment of grazing fees. On January 1, 1926, delinquent fees in the amount of $124,232.57 had not been collected. During the season of 1926 delinquent fees amounted to $39,645. A large portion of this amount was collected before the beginning of the 1927 season. The amount of delinquency (less than 1 per cent) is probably far less than that suffered by private business. While it is believed that this is a fair showing, the collection of delinquent amounts is a burdensome task upon the local forest officers.

TABLE 11.—*Delinquent grazing fees, December 31, 1926*

SUMMARY BY YEARS

Year	Cattle and horses		Sheep and goats		Total		Per cent collected
	Number of permittees delinquent	Amount delinquent	Number of permittees delinquent	Amount delinquent	Number of permittees delinquent	Amount delinquent	
1921 [1]	186	$20,993.98	27	$2,102.49	213	$23,096.47	70
1922 [1]	304	16,067.14	29	1,489.73	333	17,556.87	79
1923 [1]	187	13,274.15	8	173.32	195	13,447.47	84
1924 [1]	172	11,882.29	7	445.12	179	12,327.41	85
1925 [1]	493	12,647.34	70	5,511.65	563	18,158.99	55
1926	1,116	24,759.39	239	14,885.97	1,355	39,645.36	
Total	2,458	99,624.29	380	24,608.28	2,838	124,232.57	

[1] Districts 1, 4, and 5 figures as of Jan. 1, 1926, for years 1921–1925, inclusive.

TABLE 11.—*Delinquent grazing fees, December 31, 1926*—Continued

SUMMARY BY DISTRICTS

District	Cattle and horses		Sheep and goats		Total	
	Number of permittees delinquent	Amount delinquent	Number of permittees delinquent	Amount delinquent	Number of permittees delinquent	Amount delinquent
1 [1]	219	$7,366.18	20	$1,622.77	239	$8,988.95
2	605	25,100.35	88	5,703.08	693	30,803.43
3	378	43,076.56			378	43,076.56
4 [1]	1,056	17,774.74	240	15,166.73	1,296	32,941.47
5 [1]	101	3,194.56	9	776.55	110	3,971.11
6	99	3,111.90	23	1,339.15	122	4,451.05
Total	2,458	99,624.29	380	24,608.28	2,838	124,232.57

[1] Districts 1, 4, and 5 figures as of Jan. 1, 1926, for years 1921–1925, inclusive.

RANGE IMPROVEMENTS

The importance of such range improvements as boundary, drift, and division fences, water developments, driveways, pastures, corrals, and the eradication of poisonous plants is becoming more apparent as better grazing administration and range management are perfected. In fact, proper administration of the grazing resource is dependent to a large degree upon the adequacy of such improvements. The present status of these developments is best shown in Table 12.

TABLE 12.—*Range improvements constructed on national forests to December 31, 1926*

	District 1	District 2	District 3	District 4	District 5	District 6	Total
Boundary and drift fences—miles	299	646	4,145	847	934	646	7,517
Water developments—number	177	364	35	703	406	352	2,037
Driveways—miles	574	1,008			44	93	1,719
Bridges—number	12	14	17		7	4	54
Trails—miles				205	26	115	346
Corrals—number	47	68	29	96	184	84	508
Cabins—do				3	191	59	253
Pastures—do				8	415	8	431
Poison eradication—acres	106	6,964	200	3,077	573	76	10,996
Salt troughs—number				25	1,492	852	2,369
Miscellaneous				3	106	[1] 4,300	
Cost to stockmen	$39,158	$79,157	$2,165,071	$163,984	$302,584	$126,303	$2,876,257
Cost to Government	92,296	97,176	132,615	123,915	41,477	27,224	514,703
Total cost	131,454	176,333	2,297,686	287,899	344,061	153,527	3,390,960

RANGE IMPROVEMENTS NEEDED

Boundary and drift fences—miles	328	161	3,067	503	324	599	4,982
Water developments—number	268	138	317	525	629	469	2,346
Driveways—miles	574	1				111	686
Bridges—number	34	1		9	3	18	65
Trails—miles	19		79	139	20	88	345
Corrals—number	36	15	128	21	4	45	249
Cabins—do	17			13	3	29	62
Pastures—do				15	42	2	59
Poison eradication—acres	440	1,679	232,171	34,587	2,450	1,708	273,035
Salt troughs—number	249				1,794	1,306	3,349
Miscellaneous		15				[1] 5,000	
Cost to stockmen	$27,337	$34,016	$326,924	$109,906	$46,390	$12,478	$557,051
Cost to Government	220,503	48,966	355,812	230,929	80,971	224,457	1,161,638
Total cost	247,840	82,982	682,736	340,835	127,361	236,935	1,718,689

[1] Acres, squirrel eradication.

DAMAGE BY RODENTS AND PREDATORY ANIMALS

Stockmen suffer serious losses every year from predatory animals, especially coyotes, wolves, and mountain lions. Game animals also suffer severely. It has been estimated that the loss to the stockmen amounts to $10,000,000 each year. The Bureau of Biological Survey of the United States Department of Agriculture wages a constant warfare upon predatory animals, cooperating with the State authorities, forest officers, and the stockmen themselves. While excellent results have followed, it has been impossible with the funds available to cover fully the vast area of country infested.

Similarly the presence of prairie dogs and other rodents on many of the forest ranges reduces seriously the forage needed for the livestock. The Bureau of Biological Survey, in cooperation with stockmen and forest officers, has done very effective work on several national forests in Colorado, New Mexico, and Arizona during the past year, and the ranges cleared of these pests will show early improvement. This work should be materially extended.

The losses of permitted livestock during the calendar year 1926 were far less than in the previous year for cattle and horses but slightly greater for sheep and goats. In district 3 (Arizona and New Mexico) the number of cattle and horses lost decreased from 25,125 to 7,289, and for all districts from 37,250 to 18,074. District 3 likewise had much smaller losses of sheep and goats in 1926 than in 1925, with a drop from 9,033 to 3,834; but in each of the other districts there was an increase, and the total for all districts was 138,120, as against 127,704 in 1925.

TABLE 13.—*Livestock losses*

CATTLE AND HORSES

District	Stock lost from larkspur		Stock lost from all poisonous plants including larkspur		Stock lost from predatory animals and other causes, excluding poisonous plants		Total stock lost all causes	
	Number	Value	Number	Value	Number	Value	Number	Value
1	167	$8,265	196	$9,800	708	$28,320	904	$38,120
2	1,729	73,955	1,911	95,550	1,826	73,040	3,737	168,590
3			976	48,800	6,313	252,520	7,289	301,320
4	1,595	60,794	2,330	116,500	1,626	65,040	3,956	181,540
5	180	4,580	318	15,900	868	34,720	1,186	50,620
6	45	1,955	170	8,500	616	24,640	786	33,140
Total	3,716	149,549	5,901	295,050	11,957	478,280	17,858	773,330

SHEEP AND GOATS

1			2,519	25,190	13,326	133,260	15,845	158,450
2	155	1,538	2,863	28,630	14,963	149,630	17,826	178,260
3			860	8,600	2,974	29,740	3,834	38,340
4			11,454	114,540	58,154	581,540	69,608	696,080
5			2,437	24,370	9,945	99,450	12,382	123,820
6	53	477	3,309	33,090	15,316	153,160	18,625	186,250
Total	208	2,015	23,442	234,420	114,678	1,146,780	138,120	1,381,200

Total number lost, all classes of stock 155,978
Total value, all stock lost $2,154,530

RECREATION AND GAME

The total number of people using the national forests for recreation increased 12 per cent in 1926 as compared with 1925. Special-use permittees and their guests increased 8.5 per cent, hotel and resort guests 13.5 per cent, picnickers 15.3 per cent, and transient motorists 14.6 per cent. On the other hand, campers decreased 3.3 per cent.

The year saw 158 camp grounds improved in whole or in part; there are now 757 with some improvements out of more than 1,500 now used heavily

by the public. The expenditures for this purpose were $41,072. The total cost of the improvements to date has been $199,671, of which $42,522 has been contributed in cash, material, or labor by private or public cooperators.

The situation as to camp-ground improvements is as shown in Table 14.

TABLE 14.—*Number of national-forest camp-ground improvements to December 31, 1926, and additional improvements needed*

Class of improvement	Total constructed to Dec. 31, 1926	Additional numbers needed	Class of improvement	Total constructed to Dec. 31, 1926	Additional numbers needed
Water supplies	156	541	Booths, registration, etc	124	562
Toilets	1,746	4,614	Fences, miles	29	73
Garbage pits	1,321	4,754	Clearings, acres	1,923	1,292
Fireplaces	1,073	6,193	Miscellaneous	2	1,600
Tables and benches	1,814	8,141			
Shelters	82	390	Total	8,333	28,338
Footbridges	63	178			

To complete the improvements listed above would cost approximately $515,000. Practically all of the 1,500 areas used heavily for camping purposes by the public would then be reasonably supplied with simple conveniences, while camping would be concentrated where the fire risk is low and the presence of campers does not menace the purity of the water supplies of communities.

Every effort is being made by the Forest Service to eliminate insanitary conditions upon national-forest lands, but upon some areas unsatisfactory conditions still exist.

The national forests are rich in resources of very great value for other than purely material purposes. As our population grows and land use becomes more intensive, there will be an increasingly felt need for wilderness areas where refreshment of body and spirit may be obtained in the surroundings of unspoiled nature, and where the choicest features of our great mountain regions may be enjoyed in all of their native beauty and grandeur. It is not too soon to give thought to future social requirements along these lines and to make definite provisions for them, in due measure, as a part of the planning necessary for the orderly development of forest resources and the realization from them of the maximum public benefits.

It will, therefore, be the aim to keep substantial portions and some of the outstanding scenic features of the national forests available for forms of recreation impossible where automobile roads, commercial enterprises, and other popularizing facilities for use are encouraged. Excluding Alaska, one-third of the gross area of the national forests is in roadless areas of 10 townships (that is, 230,000 acres) or more each; and even when the road-and-trail program now mapped out is completed, more than one-fourth will be in such areas. This will not prevent the orderly use of timber, forage, and water resources as future needs may dictate. It will, however, prevent the unwise destruction of recreational values which are steadily attaining greater social significance and importance. The Forest Service plans to withhold these areas against unnecessary road building and forms of special use of a commercial character which would impair their wilderness character.

Game administration is occupying a more important place in forest administration as the problems involved are more clearly perceived and as forest officers continue to study the requirements of wild life and develop the plans necessary for its protection and perpetuation. Table 15 shows the latest estimate of game animals on the national forests:

TABLE 15.—*Number of big game animals and beaver on national forests; estimates as of December 31, 1926*

[Summary by States]

State	Antelope	Bear		Caribou	Deer	Elk	Moose	Mountain goats	Mountain sheep	Beaver
		Black or brown	Grizzly							
Alaska		[1] 5,900	[2] 5,000		57,300		2,050	9,000	2,000	
Alabama					100					
Arizona	1,971	601	14		59,368	758			239	72
Arkansas					1,150					
California	526	10,894			236,660	131			775	219
Colorado	164	2,704	18		26,115	8,295			3,888	45,275
Florida		20			610					
Idaho	1,745	5,064	133	64	60,105	6,840	737	3,042	1,276	15,110
Michigan		31			225					
Minnesota		725		3	4,365		1,075			4,208
Montana	917	5,375	441	6	51,487	10,593	1,185	4,248	1,796	16,060
Nebraska					50					
New Hampshire		525			2,530					
New Mexico	961	664	19		25,027	85			200	811
Nevada	107	41			5,340				175	175
North Carolina		80			3,204	30				
Oklahoma	22				250	300				
Oregon	47	6,215	2		71,339	4,471			40	5,619
Pennsylvania		200			1,050	15				25
South Dakota					2,370	547		3		2,763
Tennessee		27			65					
Utah	15	368	16		24,891	1,715			247	7,846
Virginia		450			30	100				
Washington		6,420	35	101	26,320	9,590		2,125	10	9,111
West Virginia		100			30					
Wyoming	467	1,461	136		11,069	39,008	2,145		2,639	8,382
Total	6,942	47,865	5,814	174	671,050	82,478	7,192	18,418	13,285	115,676

[1] Black bear only.

[2] Including Alaska brown bear.

This estimate raises the deer population by approximately 65,000 head, the elk by over 10,000, and moose by approximately 1,000, while mountain goats and mountain sheep show little change. In many localities better provision for their protection should be made.

Elk are now found on 95 national forests, in numbers ranging from 1 head on the Chelan to approximately 20,000 on the Teton. Each of the larger herds represents a special problem. The carrying capacity of the range should govern the extent to which the herds are allowed to increase. Good game administration calls for determining the limit thus imposed and the best means of holding the herd within it. Such a course requires the closest cooperation of State, sportsman, and Federal agencies.

In line with this conception, the chairman of the President's committee on outdoor recreation called a meeting during the latter part of March of all agencies interested in the Jackson Hole elk herd. After a thorough discussion plans were formulated for meeting the critical situation which occurs at periodic intervals with this herd. It is believed the plans then formulated will solve this problem. The field officers of the Forest Service continued to study the conditions influencing the welfare of the northern Yellowstone elk. Particular attention was given to the development of a plan for the acquisition of the private holdings within the area north of the Yellowstone National Park, which, as a means of protecting the elk and antelope, was added to the Absaroka and Gallatin National Forests by the act of Congress approved May 26, 1926.

Forest officers referred to State officials for prosecution 617 game law cases which resulted in 347 convictions. Under "Forest Service cases," 201 cases were investigated, which resulted in 102 arrests and 99 convictions.

Forest officers also issued 7,286 State game licenses and examined 22,286. This form of cooperation has increased

the respect for game laws and has aided State officials materially in the protection of wild life.

The deer herd on the Kaibab National Forest continues to present a difficult problem; but the prospect for its solution was decidedly improved when at the close of the fiscal year, the United States District Court for Arizona, northern division, entered a decree sustaining the right of the United States to prevent further damage or injury by the deer to the Kaibab National Forest and Grand Canyon National Game Refuge. The decree enjoins the State and county officers from enforcing the game laws of Arizona against officers, agents, servants, or employees of the United States engaged in carrying out the regulations or orders of the Secretary of Agriculture for reducing the number of deer and for removing them or their carcasses to places within or without the State. The decree stipulates, however, that it shall not be construed to permit the licensing of hunters to kill deer within the forest or preserve in violations of the game laws of the State.

The canyons and deserts which surround the Kaibab Forest preclude the migration of excess game to other regions. The 4,000 deer estimated as on the area when it was made a game refuge in 1906 have grown to a herd of approximately 30,000. Although progressive reductions have been made in the numbers of cattle and sheep permitted to graze on the forest until only a negligible number now use it, the entire area is overgrazed and upon about one-half of it the damage to tree growth and undergrowth threatens the future of the forest. The deer so far exceed the normal capacity of their range that they are forced to subsist destructively upon the young trees and shrubs; and it is estimated that since November, 1924, 10,000 deer have starved. A bad season might result in the almost total extinction of the herd.

Extended study, accomplished in part by a committee of game experts of national reputation, has demonstrated that the only feasible means of protecting either the forest or the game is to reduce materially the number of deer. The State of Arizona was authorized to drive 5,000 deer to other regions, but the attempt proved wholly impracticable. Efforts to ship first adult deer and later fawns to other localities in any large numbers also proved impracticable. Controlled killing of the excess deer is the only way left to avert the damage to the forest and the growing menace to the herd.

The game laws of Arizona allow hunting only during the month of October and the killing of only one male deer; while they prohibit transportation of carcasses from the State and impose a charge of $20 upon nonresidents. Adequate reduction in the number of deer would obviously be impossible under these limitations. The Secretary of Agriculture authorized by regulation the killing of not to exceed three deer per hunter under cooperative agreement with the Forest Service, with a hunting period of two months and a charge of $5 per deer. The Governor of Arizona, however, directed the State officers to apprehend and prosecute all persons hunting in violation of the State game laws. This forced resort to the courts. The United States sought a restraining order upon the ground that both the lands within the game refuge and the deer thereon were the property of the United States, which therefore had the right to kill and possess the deer, to transport them outside its own lands and outside the State of Arizona, and to delegate its rights to persons cooperating with it. The court declined to pass upon the question of ownership of the game; but its decree practically confirms all of the contentions of the United States except that of the power to delegate to hunters the right to kill and remove the deer.

WATER POWER

Table 16 shows the status on June 30, 1927, of water-power permits granted by the Department of Agriculture under the provisions of the acts of February 15, 1901, February 1, 1905, and March 4, 1911. The number of permits outstanding on June 30, 1927, was 26 less than at the end of the preceding fiscal year. This reduction was due in part to the abandonment of proposed power development. In large measure the remaining relinquishments were due to the redesign of the power projects, necessitating more land and permits or licenses from the Federal Power Commission.

The Federal Power Commission requested the Forest Service to make field investigations and reports in 46 cases and to supervise and inspect the operations of 51 permittees or licensees. Fifty-eight reports were made during the year and at its end the Forest Service was supervising operations in

247 cases. Of the 97 applications received by the Federal Power Commission during the year, 50 involved the use of national-forest land.

TABLE 16.—*Water-power development and transmission-line rights of way under permit or easement, fiscal year 1927*

Class of permits or easements	Transmission lines only			Power projects (reservoirs, conduits, and power houses)		Total permits or easements
	Number of permits or easements	Length in miles		Number of permits or easements	Estimated average output at minimum discharge (horsepower)	
		Within national forest boundaries	On national forest land			
Permits or easements in force at close of fiscal year:						
Rental	125	962.26	716.66	63	543,253	188
Free permits or easements	22	155.40	127.83	68	26,272	90
Total	147	1,117.66	844.49	131	569,525	278
Construction completed at close of fiscal year:						
Rental permits or easements	125	962.26	716.66	59	365,419	184
Free permits or easements	22	155.40	127.83	64	26,202	86
Total	147	1,117.66	844.49	123	391,621	270
Construction incomplete at close of fiscal year:						
Rental permits or easements				4	177,834	4
Free permits or easements				4	70	4
Total				8	177,904	8

From the standpoint of the national forests the most important water-power action during the year was the granting of two preliminary permits for power development in the Tongass National Forest in Alaska. One of these involved Long and Crater Lakes and their outlets and the other a combination of nine different projects in the vicinity of Ketchikan. The power capacity in each case is large. The primary purpose of development is the manufacture of wood pulp. These cases were handled in accordance with the policy approved by the Forest Service and the Federal Power Commission several years ago, to coordinate action so as to make Alaskan power and timber available to the applicant presenting the most desirable project for their joint development. The Forest Service had previously allocated a unit of timber supply to each group of power sites. Upon receipt of applications for the timber, it was advertised for sale and the successful bidder was granted a preliminary power permit.

These proposed power developments are noteworthy not only because of their effect on the welfare and growth of southeastern Alaska and the utilization of national-forest resources but because the utilization of one resource—power—is based entirely on utilization of another resource—timber.

Future power development in Alaska was aided by the airplane-photography expedition of the United States Navy. Planning of one of the two large developments mentioned in the preceding paragraphs was based very largely on topographic conditions brought out by the Navy photographs. Not as many undiscovered power sites were revealed as had been hoped, but it is believed that further sites will be found as the work covers additional portions of the national forests.

It is regretted that conditions prevented completion in 1927 of all the photographic work on the Tongass Forest. Its completion in the summer of 1928 is hoped for. To date some 5,000 sets of three pictures each are available. Making prints of these was

a tremendous undertaking and is not yet completed. The Geological Survey has begun the preparation of a map based on the photographs, which will be of immense value to the Forest Service and to users of the Tongass Forest.

ROADS AND TRAILS

The accomplishments in and the expenditures made for forest road and trail construction and maintenance in the various States containing national forests are given in Table 17.

TABLE 17.—*Construction, improvement, and maintenance of roads and trails from forest road appropriations and other Federal and cooperative funds by States, June 30, 1927*

State	Fiscal year 1927				Total to June 30, 1927		Expenditure to June 30, 1927		
	Constructed		Maintained		Constructed				
	Roads	Trails	Roads	Trails	Roads	Trails	Federal funds	Cooperative funds	Total
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*			
Alabama	3.6		22.0		10.1		$50,987.59	$1,982.65	$52,970.24
Alaska	23.6	42.4	156.5	270.6	186.6	270.6	3,071,994.25	237,573.17	3,309,567.42
Arizona	134.5	56.3	815.4	646.8	822.6	1,397.3	3,717,018.41	826,798.24	4,543,816.65
Arkansas	61.6	29.0	118.0	337.2	341.4	478.1	773,631.39	24,647.73	798,279.12
California	121.3	224.7	2,241.2	5,064.5	1,285.9	2,392.8	9,058,748.43	3,075,678.10	12,134,426.53
Colorado	84.7	719.4	668.3	7,473.4	1,058.2	3,309.7	4,716,255.73	741,976.24	5,458,231.97
Florida	15.5		170.8	36.5	125.6		241,099.56	136,311.18	377,410.74
Georgia	13.3		56.6	168.6	32.8	168.6	278,886.61	923.60	279,810.21
Idaho	146.8	978.5	2,073.6	8,709.7	1,672.8	6,011.4	9,491,792.39	1,440,116.33	10,931,908.72
Illinois							4.00		4.00
Kansas					3.4		2,111.51		2,111.51
Kentucky							33.10		33.10
Maine	.3		3.8	40.8	5.3	40.8	24,185.88		24,185.88
Maryland							5.52		5.52
Michigan	.2		40.0		22.2		14,301.07	393.45	14,694.52
Minnesota	63.2	19.5	143.5	64.0	293.6	103.2	444,687.16	232,717.59	677,404.75
Montana	69.0	710.8	1,010.7	6,389.0	854.0	2,930.1	5,881,616.86	547,237.61	6,428,854.47
Nebraska	5.0		20.7		46.3		68,636.66	990.80	69,627.46
Nevada	32.1	13.5	319.1	306.0	423.0	765.0	1,027,040.19	128,933.16	1,155,973.35
New Hampshire	2.5	33.8	33.8	330.2	35.0	330.2	201,342.47	5,765.17	207,107.64
New Jersey							15.37		15.37
New Mexico	75.6	70.5	429.2	950.0	592.0	1,287.0	2,844,364.21	243,551.09	3,087,915.30
New York							13.06		13.06
North Carolina	19.5	3.0	149.5	568.3	171.2	568.3	526,638.78	50,054.94	576,693.72
North Dakota					1.0		57.75		57.75
Oklahoma	.2		29.4		24.7	16.5	46,293.43	10,513.61	56,807.04
Oregon	226.0	806.0	3,461.4	6,491.0	2,098.8	3,218.8	8,765,976.61	5,059,539.66	13,825,516.27
Pennsylvania	8.0		83.0		42.0		40,146.07	1,005.00	41,151.07
Porto Rico	1.0			36.3	1.0	36.3	14,059.34	550.00	14,609.34
South Carolina			16.9		16.3	4.0	73,458.69	3,462.71	76,921.40
South Dakota	22.0	5.2	145.6	50.0	241.1	53.2	601,979.17	172,891.01	774,870.18
Tennessee	3.7	14.5	47.8	436.1	82.0	450.6	259,880.75	129,572.16	389,452.91
Utah	67.0	417.3	656.0	1,388.8	957.7	2,825.1	2,567,498.44	699,083.39	3,266,581.83
Virginia	10.3	3.5	60.7	603.6	111.6	682.1	403,717.29	36,657.43	440,374.72
Washington	67.1	476.6	879.7	6,069.0	746.4	2,204.2	5,552,677.18	1,451,627.39	7,004,304.57
West Virginia	9.7	14.2	38.7	253.5	42.9	354.8	104,356.10	3,242.91	107,599.01
Wyoming	82.4	348.6	701.7	3,982.7	871.0	1,708.5	3,123,996.30	348,159.95	3,472,156.25
Total	1,369.7	4,987.3	14,593.6	50,666.6	13,218.5	31,607.2	63,989,507.32	15,611,956.27	79,601,463.59

The apportionment among the States of the fiscal year authorization and of the total appropriations and authorizations, and the condition of these road appropriations July 1, 1927, are shown in Tables 18 and 19.

TABLE 18.—*Distribution among the States of the total appropriation and of the apportionment for the fiscal year 1928*

State	10 per cent fund		Section 8 fund	Federal forest road construction fund
	Fiscal year 1928	Total	Total	Total
Alabama	$84.44	$610.94	$15,456.04	$1,922.31
Alaska	16,772.58	133,175.77	467,677.05	192,760.71
Arizona	22,941.49	500,533.07	602,270.53	502,219.41
Arkansas	10,826.60	88,877.93	174,939.40	129,268.41
California	116,575.10	1,075,415.33	1,458,839.48	1,199,453.89
Colorado	40,237.77	551,399.80	757,397.81	778,160.67
Florida	3,058.91	28,591.10	119,528.14	22,001.25
Georgia	1,133.94	7,343.92	51,184.94	134,437.03
Idaho	54,521.28	714,567.86	1,192,821.16	1,368,155.19
Kansas		1,867.27		
Kentucky	326.39	492.49		
Maine	221.16	2,009.34	32.41	3,738.77
Maryland	55.05	55.05		
Michigan	183.76	1,127.96	7.00	3,000.00
Minnesota	4,812.67	28,968.12	7,928.63	108,237.34
Montana	20,529.16	493,055.41	751,906.10	731,615.64
Nebraska	1,112.88	15,615.26	18.98	
Nevada	9,377.99	139,292.79	194,631.77	82,413.97
New Hampshire	2,929.25	25,727.63	341.66	10,857.64
New Jersey	33.50	48.82		
New Mexico	12,755.86	298,230.94	429,092.69	509,977.19
North Carolina	2,011.99	26,295.50	84,556.25	177,013.35
North Dakota		45.75	7.00	
Oklahoma	575.06	7,817.81	65.49	2,775.17
Oregon	75,717.56	734,627.86	1,425,679.58	1,075,674.15
Pennsylvania	−46.10	247.28	24.04	21.42
Porto Rico		3.70	7.00	3,343.09
South Carolina	363.62	1,268.24	402.10	48,150.05
South Dakota	11,569.92	123,980.11	83,388.00	79,721.47
Tennessee	1,413.27	14,384.67	78,254.65	28,154.47
Utah	18,649.70	320,654.58	444,880.79	465,678.07
Virginia	3,513.52	28,985.52	58,101.01	72,065.82
Washington	60,920.14	423,147.56	937,858.25	714,414.12
West Virginia	421.27	3,327.07	12,830.41	5,049.24
Wyoming	20,440.95	324,788.15	470,544.67	548,767.92
Undistributed			179,326.97	952.24
Total	514,040.68	6,116,580.60	10,000,000.00	9,000,000.00

State	Forest highway fund		Forest road development fund		Grand total
	Appropriated and authorized, fiscal year 1928	Total	Appropriated and authorized, fiscal year 1928	Total	
Alabama	$3,954.00	$20,123.00	$6,979.00	$32,276.00	$70,388.29
Alaska	472,547.00	3,102,059.00	20,562.00	156,338.00	4,052,010.53
Arizona	279,246.00	1,868,831.00	135,777.00	913,299.00	4,387,153.01
Arkansas	34,472.00	223,353.00	50,464.00	297,566.00	914,004.74
California	680,140.00	4,572,028.00	423,834.00	2,640,400.00	10,946,136.70
Colorado	335,131.00	2,252,070.00	145,576.00	1,146,240.00	5,485,268.28
Florida	12,071.00	75,930.00	23,491.00	81,175.0	327,225.49
Georgia	11,648.00	56,803.00	21,997.00	99,943.00	349,711.89
Idaho	509,561.00	3,423,813.00	636,277.00	4,155,913.00	10,855,270.21
Illinois	390.00	781.00	206.00	396.00	1,177.00
Kansas					1,867.27
Kentucky	1,608.00	3,218.00	1,832.00	5,064.00	8,774.49
Maine	1,272.00	8,535.00	1,204.00	11,854.00	26,169.52
Maryland	352.00	704.00			759.05
Michigan	2,383.00	14,422.00	11,430.00	54,159.00	72,715.96
Minnesota	29,302.00	197,579.00	34,889.00	272,665.00	615,378.09
Montana	403,447.00	2,724,482.00	288,252.00	2,261,937.00	6,962,996.15
Nebraska	4,661.00	33,531.00	1,193.00	25,667.00	74,832.24
Nevada	96,603.00	650,489.00	4,499.00	98,873.00	1,165,700.53
New Hampshire	16,437.00	108,892.00	13,821.00	92,679.00	238,497.93
New Jersey	837.00	1,674.00	411.00	791.00	2,513.82

TABLE 18.—*Distribution among the States of the total appropriation and of the apportionment for the fiscal year 1928*—Continued

State	Forest highway fund		Forest road development fund		Grand total
	Appropriated and authorized, fiscal year 1928	Total	Appropriated and authorized, fiscal year 1928	Total	
New Mexico	$210,424.00	$1,422,383.00	$116,239.00	$733,615.00	$3,393,298.82
New York	705.00	1,411.00	514.00	970.00	2,381.00
North Carolina	14,098.00	90,052.00	34,742.00	190,061.00	567,978.10
North Dakota					52.75
Oklahoma	2,109.00	16,294.00	359.00	21,955.00	48,907.47
Oregon	579,801.00	3,805,734.00	537,103.00	3,111,717.00	10,153,432.59
Pennsylvania	5,492.00	15,761.00	9,162.00	46,179.00	62,232.74
Porto Rico	597.00	4,356.00	306.00	11,561.00	19,270.79
South Carolina	2,199.00	8,454.00	5,194.00	33,934.00	92,208.39
South Dakota	35,263.00	238,517.00	19,224.00	151,407.00	677,013.58
Tennessee	11,677.00	66,647.00	15,919.00	102,019.00	289,459.79
Utah	172,562.00	1,160,066.00	48,128.00	460,193.00	2,851,472.44
Virginia	17,287.00	96,342.00	28,560.00	179,017.00	434,511.35
Washington	325,485.00	2,208,795.00	277,595.00	2,251,005.00	6,535,219.93
West Virginia	5,311.00	28,525.00	18,817.00	80,403.00	130,134.72
Wyoming	220,928.00	1,497,346.00	65,444.00	778,729.00	3,620,175.74
Undistributed					180,279.21
Total	4,500,000.00	30,000,000.00	3,000,000.00	20,500,000.00	75,616,580.60

TABLE 19.—*Condition of forest road funds on June 30, 1927*

Fund	Total appropriations	Total expenditures	Unexpended balance
10 per cent	$5,602,539.92	$5,207,229.18	$395,310.74
Section 8	10,000,000.00	9,361,511.26	638,488.74
Federal forest road construction	9,000,000.00	8,955,611.57	44,388.43
Forest highway	25,500,000.00	22,848,334.31	2,651,665.69
Forest road development	17,500,000.00	16,210,686.48	1,289,313.52
Total	67,602,539.92	62,583,372.80	5,019,167.12

TABLE 20.—*Forest highway and forest road development funds appropriated for fiscal years 1922 to 1927, inclusive*

Fiscal year	Forest highway fund	Forest road development fund	Fiscal year	Forest highway fund	Forest road development fund
1922	$2,500,000	$2,500,000	1925	$3,500,000	$3,000,000
1923	7,000,000	3,000,000	1926	4,500,000	3,000,000
1924	3,500,000	3,000,000	1927	4,500,000	3,000,000

The amount of forest highway and forest road development funds actually appropriated for each fiscal year is shown in Table 20.

At the close of the fiscal year the transportation system planned as necessary within 10 years for the protection, utilization, administration, and development of the national forests comprised 51,268 miles of road and 110,385 miles of trails. To complete it will require an estimated expenditure of $177,124,616. Considering the large area of the national forests the system is not intensive. The classification and status of the mileage and the estimated expenditures are shown in detail in Table 21.

TABLE 21.—*Classification of road mileage and estimated expenditures*

System	Total	Satisfactory	Unsatisfactory	Nonexisting	Expenditures required to complete
	Miles	*Miles*	*Miles*	*Miles*	
Forest highways	15,068	5,084	8,687	1,297	$123,916,067
Forest development roads	36,200	10,910	14,767	10,523	47,528,558
Trails	110,385	73,431	12,461	24,493	5,679,991
Total					177,124,616

The average annual expenditure from the forest highway and forest road development funds for the past three years has been approximately $8,400,000. The expenditure program for the fiscal year 1928 is $7,500,000, although a larger amount is available for obligation. Assuming that no increase in mileage will be made in the system as now planned and that the present proposed standards and estimated costs do not vary, an annual appropriation of $4,500,000 for forest highways and $3,000,000 for forest development roads and trails would permit the completion of the road system within 31 years and of the trail system within 8 years. On the other hand, the public will doubtless demand a larger mileage as more intensive use is made of the forests.

MAPS AND SURVEYS

There were printed 25 maps on the scale of one-fourth inch to the mile and 17 maps on the scale of one-half inch, incorporating the results of Forest Service surveys and other data. There were also issued an index map of the United States showing all the national forests, State forests, national parks, national monuments, and Indian reservations, seven proclamation diagrams, and an eight-page atlas folio. Numerous small maps, charts, and illustrations were lithographed.

In Idaho, Montana, Utah, and Washington approximately 2,100 square miles of virgin forest land were mapped for drainage. These surveys were based on accurate data and only differed from a regular topographic survey in that vertical control was not extended and contour lines were not delineated. A triangulation net extending over approximately 1,000 square miles of the Tonto National Forest in Arizona was surveyed to the standards prescribed by the Federal Board of Surveys and Maps.

The phototopographic survey made by the Navy Department by airplane embraced practically all of southeastern Alaska except Baranof and Chichagof Islands. The photographs were taken at an altitude of approximately 10,000 feet, and are on a horizontal scale of approximately 1,660 feet to the inch. Arrangements have been made with the Navy Department and the Geological Survey whereby prints of these photographs may be purchased by the public. The map that is being compiled by the Alaskan branch of the Geological Survey from these photographs will be on a horizontal scale of 1:180,000, or approximately 15,000 feet to the inch.

In connection with the aerial fire patrol in Idaho, an aerial photographic survey covering about 64 square miles in the Kaniksu National Forest was conducted for experimental purposes. A K–3 single-lens camera was borrowed from the Army Air Corps. The area was photographed from an altitude of approximately 10,000 feet. A serviceable mosaic map on the scale of 6 inches to the mile was made from the photographs.

Numerous small projects involving timber, grazing, and land-exchange areas were topographically surveyed.

The General Land Office surveyed approximately 150 townships within or partly within the national forests, but the Geological Survey has made little progress in mapping national-forest lands since the passage of the Temple Act. Fifty-four per cent, or about 99,000,000 acres, of the national forests are without accurate topographic surveys. These surveys constitute an essential administrative tool in connection with proper development and utilization of forest resources and efficient fire protection. The urgency for extending them can hardly be overstressed.

RESEARCH

The size and complexity of the task of research in connection with forestry becomes more evident the more closely

it is approached. The problems to be solved are of almost infinite number and diversity. They go far deeper than the development of the most economical and profitable methods of growing timber and utilizing forest products. They necessitate fundamental research in the various natural sciences which relate to soils, plant life, and the organic substances which forests supply; they necessitate thoroughgoing industrial research that will make possible the best adjustment between our forest resources and our manifold requirements; and they necessitate economic research aimed at the whole great problem of land use, from the standpoint of present and future national needs.

For the forest problem can not be isolated from the rest of our land problem and worked out separately. The various forms of land use interlock. Of our nearly 3,000,000 square miles of land area all but a wholly insignificant fraction must make its contribution to the Nation's life as tilled land, grazing land, or forest land. How shall the line between these be drawn? Increase of population will put increasing pressure on the land, both for food and for the raw materials of industry. How to bring about on all the land the kind and method of use that will be most advantageous in the long run is the most vital material problem confronting the country. Well-directed research will enable us to advance on the right road. It will enable us to obtain dependable knowledge of what land should be employed in forest crops, of the effect of present practices upon timber growing, and of the methods of production and utilization that will be most efficient. On such knowledge public policies of forestry can be securely based and the extension of private forestry soundly guided.

FOREST EXPERIMENT STATIONS

In continuance of the policy which aims to build up throughout the country a series of forest experiment stations, one for each of the major forest regions, two new experiment stations were provided for by Congress last year. One of these, the Allegheny, will serve the needs of the Middle Atlantic States exclusive of New York, which is served by the already established northeastern station. The other will have for its field the predominantly agricultural region from Ohio westward to Iowa and Missouri, with part of Kentucky and Tennessee. Farm forestry, the place of the wood lot in farm economy, and the best use of marginal and submarginal agricultural lands in the region will mainly occupy the attention of this station.

Including these additions, the regional forest experiment stations now provided for are the Northeastern, the Allegheny, the Appalachian, the Southern, the Central States, the Lake States, the Northern Rocky Mountain, the Pacific Northwest, and California. The central Rocky Mountain region and the Southwest remains to be equipped for forest research on a basis comparable to that of the other principal regions.

While rapid progress has been made in establishing the series of forest experiment stations the development of the individual stations has by no means kept pace with the growing demand for technical information upon which to build sound timber-growing policies and practices. One outstanding requirement is for the expansion of the work in the Pacific Northwest to include Alaska. The establishment of large pulp and paper enterprises in Alaska will necessitate information as to the best methods of cutting to insure quick regeneration, the time necessary to grow a new forest crop, and the area necessary to insure a continuous supply of raw material for plants of a given size. In California also a considerable expansion of the work is needed to cover adequately the major forest subdivisions. The rapid growth of the State is placing a heavy demand upon its forests, and if California is to supply her own wood requirements intensive forest management must be developed. There are now over 10,000,000 acres of virtually idle brush lands, most of which might be growing a valuable forest crop.

Investigations in the Lake States have been concentrated on a few large problems, such as increasing the forest growth of swamps by drainage and applying selective logging in the northern hardwoods so as to permit the remaining forest to be handled on a perpetual basis. In this region, however, a vast extent of former pine land is now denuded of pine, burned, and reproducing with aspen, birch, and scrub oak. These lands are comparatively close to large consuming centers. How to reclaim them and convert their scrub growth into a valuable forest is an outstanding economic problem, upon which im-

mediate silvicultural work is necessary.

Each region has its own group of problems peculiar to its own local forest types, climate, and soils. Studies under way include those to determine the best methods of harvesting old timber in order to reproduce a crop of desirable tree species in the shortest possible time, to determine the actual rate of growth and the yield of wood produced at various ages, to demonstrate methods of forest planting for denuded land that will establish the most desirable species at the lowest possible cost and with the highest degree of success, and to determine how best to protect forests from fire. In the South studies of the production of naval stores assume primary importance, and accordingly methods of turpentining are being sought which will give the highest yields with the least injury to the forest. In the Northeast, where pulpwood production is a primary consideration, methods of management which will produce the largest yields of pulp wood are being studied. In California, studies of stream flow and of erosion are being made to learn how best to improve the vegetative cover for the protection of water sources and prevention of erosion.

The results of investigations carried on at the forest experiment stations are already proving of value. Much progress in the study of forest-fire weather has been made at the Northern Rocky Mountain Forest Experiment Station. The study has reached a point where rules have been formulated and made available for use in the measurement of weather changes which indicate fire danger. Close cooperation from the Weather Bureau in this work has resulted in the installation of a regular fire-weather warning service. Warnings are of great value to fire organizations on national forests and on private holdings in order that adequate preparations may be made for an emergency.

The natural replacement of blight-killed chestnut has been under investigation for some time. The main purpose of this study is to find out just what has happened to the big gaps in our eastern hardwood forests caused by the death of the chestnut. Results of the study thus far obtained, as set forth in Miscellaneous Circular 100, show much room for optimism. The gaps are gradually filling in by natural seeding with many different hardwoods, chiefly oaks, so that it is hardly necessary to adopt a planting program to bring these areas back into a productive condition.

A study of the yield of spruce in the Northeast is indicating the amount of wood suitable for the production of paper which may be expected from various classes of forest land. Information has been obtained as to the right time in the life of a crop of timber to cut and still maintain a full stocking of reproduction. Along with this, determinations of the rate of growth have been made which will enable the operator to plan on when he can return for a second cut after the first crop has been harvested.

Investigations of nursery practice in the northern Rocky Mountain region have disclosed a simple yet very effective method of controlling weeds through the use of chemicals. The results of this work are applicable not only in forest nurseries, where weed control is expensive, but as a means of reducing fire hazard in lumber yards, oil plants, around factory buildings, along railroad tracks, and in other places where inflammable material is a source of danger.

A planting survey in the Lake States is nearing completion. Up to and including 1926, 73,000 acres had been planted, while 20,000,000 acres are in need of reforestation by this method. Study of old plantations has developed important facts regarding methods of planting, species, and classes of stock to use on different sites and in different localities.

Studies in slash disposal are being carried on simultaneously in the western yellow-pine type of the Southwest and the Pacific Northwest. Débris resulting from logging represents a very serious fire hazard. Complete disposal of slash by broadcast burning destroys most of the young growth left on the ground. Improved methods of disposal are being developed whereby the hazard may be reduced and as much as possible of the young growth preserved.

FOREST ECONOMICS

The forest-taxation inquiry continued its investigation in Minnesota, has well under way a study in Wisconsin in cooperation with the University of Wisconsin, and did some preliminary work in Michigan. Principal attention was given to Minnesota. Intensive field studies gathered all facts bearing upon the tax situation in general and the taxation of forests in particular, in 21 townships selected from four counties in the northern part of the State and one county in

the southern part. This material was brought into relation with more general information relating to the rest of the State. Simultaneously a thorough study was made of all the special forest tax laws which States have enacted.

One thing which has become clear is that forest taxation is not a separate problem, to be isolated and studied apart from the taxation of other kinds of property. The inquiry finds itself of necessity engaged in a comprehensive study of the whole system of American State and local finance, with the forests in the center of the picture.

The plan of the inquiry is to study intensively certain key States or regions. This does not imply a series of disconnected studies, with separate conclusions and recommendations. On the contrary, the forest-tax problem of the entire Nation is regarded as the unit. While certain regions are selected for intensive study, general principles based on all the facts obtained, and on facts obtained in all parts of the country, are being sought. The announcement of conclusions is unlikely before the whole study is completed. The investigation appears likely to continue for five or six years. Early suggestions as to the best methods of forest taxation would be premature, since they would be in advance of the evidence. This, however, does not preclude placing information which has been gathered in the hands of those to whom it may be especially useful, as indeed was done in the past year. Partly with this in mind, field work will be begun in the Pacific Northwest in 1928. Here the problem is of high importance and local interests are anxious to cooperate in its solution.

The economic factors affecting the ownership of forest land in a portion of northern Wisconsin, the return obtainable from it, and its relationship to local communities was made the subject of a separate study, undertaken to learn how these factors may influence forest policies for the region.

The collection of stumpage, log, and lumber prices continued, and an analysis of the price records as a partial index of the economic practicability of timber growing was nearly completed for publication. Cooperation continued with the Bureau of the Census in gathering information on the production of lumber, lath, and shingles.

Data were obtained for studying the distribution of the hardwood and softwood lumber produced in each State. Statistics on wood preserved and preservatives consumed in 1926 were obtained and tabulated as usual.

Cooperation was undertaken with the Chamber of Commerce of the United States in preparing for a forestry conference, at which the results of a survey of the progress of forestry in the United States will be presented. The conference will deal with the commercial possibilities of forestry and the measures necessary to lessen the obstacles to private forest management. A proposed study of forestry in relation to submarginal agricultural land, in cooperation with the Bureau of Agricultural Economics, has in view through surveys of selected States to determine the basic facts and principles for a sound economic classification of land included in farms but suitable for timber growing. Means are available to undertake this project now only in a very small way.

There is also great need for a comprehensive and detailed forest survey of the entire country which would bring out all facts regarding timber supplies, imports, substitutes for wood, and growth of timber on the one hand, and on the other present requirements, rate of cutting, other drains upon the forests, and wood exports. This is the most important and fundamental of all economic studies but involves an enormous task.

These projects are suggestive of the far-reaching scope and practical importance of the field of forest-economics research. To place forestry on a sound basis the economic forces at work must be understood.

FOREST-PRODUCTS INVESTIGATIONS

Forestry will be practiced to the extent that owners of forest land have confidence that wood will hold a leading place among industrial materials and that forests will increase in value. The developments of the past year have shown with increasing clearness that research in forest products is not only a means of reducing timber waste and extending the economic service of wood but also one of the most important ways to make forestry pay.

FIELDS OF FOREST-PRODUCTS RESEARCH

The determination of wood properties and their control through methods of selection, manufacturing processes, or subsequent special treatments is a field of research which includes some of the problems most vital to successful timber utilization. There are about 150 important native

woods, each possessing over 30 properties of commercial significance such as hardness, shrinkage, resistance to decay, and heat insulation. Each of the 150 species exhibits considerable variation in its 30 or more properties, not only for the species as a whole but in each locality where it occurs. Intelligently employed, this variability of wood becomes an asset by extending the uses to which it can be satisfactorily adapted. Disregarded, it becomes a liability. Both producer and consumer need to know the range in a given property that may be expected in a commercial species of wood from a certain producing locality. This knowledge is at present available only in a limited way in the case of most of the 30 properties. The opportunity for control of wood properties begins in the forest. To grow more wood is not enough. The problem is to grow high-density wood, low-density wood, straight-grained wood, decay-resistant wood, etc. It is a matter for research, and to solve it the forester, the physicist, and the chemist must all work together.

Other fields of forest products research include a determination of use requirements and the design of wood products. For the hundreds of uses of wood there are few specifications based on technical facts and material is chosen under a wide range of opinion and prejudice. Only for a few structural uses is wood selected by properties such as density, location, and size of knots, and straightness of grain, so as to insure satisfaction for the use intended. The design of wood products presents great opportunities for research to bring about economy in usage.

Three other broad fields under which research in forest products may be grouped are the development of accessory materials for use with wood, such as glues, preservatives, paints, and fastenings; the development of more economical production processes through all stages of manufacture, distribution, and storage; and the conversion of forest materials into chemical and fibrous products, such as pulp and paper, turpentine and rosin, and lacquers.

MOST URGENT PROJECTS

These fields of research have been mapped out by the Forest Products Laboratory and summed up in an "enlarged program of 110 research projects." From this program the most urgent projects have been selected for inclusion in an expanded laboratory program. These projects bear upon immediate problems, largely those whose solution is demanded by consuming or manufacturing interests or which have a direct bearing upon the more complete and effective utilization of forest crops.

Certain of the selected projects deal with the grading of lumber for density, the correlation of mechanical, chemical, and physical properties of wood, and lumber storage and handling practice, all fields in which considerable work has already been done. On other urgent projects, such as the heat-insulating value of wood, the development of fire-resistant wooden construction, and the decay hazards in typical wooden houses, practically nothing has been done although related studies previously conducted have given the Forest Products Laboratory a good background to start from.

PROGRESS DURING THE YEAR

A major research project undertaken this year has for its object the definition in American lumber standards of (1) the degree of dryness of lumber at which the standard sizes shall apply and (2) what constitutes seasoned and unseasoned lumber in different commercial uses. Field tests proved that the proposed plan of basing standard sizes on the weight of the lumber at time of shipment was unreliable, because of the great variation in the weight of the dry wood. They also showed the actual variation in moisture content of lumber shipped from different regions as kiln dry, air dry, etc. In the case of certain pine mills, kiln-dry lumber as shipped had a moisture content averaging 9 per cent, and 80 per cent of such stock had a moisture content between 4 and 14 per cent. When similar data are obtained for other conditions and regions and when work now under way on the moisture content that woods attain under service conditions is completed the basis for trade agreement will have been provided.

The laboratory at Madison, Wis., has been working on the possibility of expressing lumber seasoning and size definitions either in terms of permissible shrinking and swelling or in terms of actual moisture content. Since either method depends upon rapid, practical means of making measurements, considerable research has been devoted to these ends. Several devices have been developed by

the laboratory for quickly determining the moisture content of wood. None of the methods is yet ready for commercial use, but with the additional refinements and tests planned the laboratory is hopeful of soon providing the industry with these much-needed tools.

In furtherance of American lumber standards the laboratory worked out a system of basic grades for hardwoods, which would (1) reduce by half the waste at mills in remanufacturing to raise grades, (2) bring together in the same grade boards of similar cutting value for the fuller use of lumber at fabricating factories, and (3) simplify the grading system to the particular benefit of small sawmill operators so that logs can be sawed to realize their highest grades. The necessary mill try outs were made to compare this system with others proposed. The outcome was that the hardwood trade, divided for years on the question of proper grades, has made unanimous recommendations to the central committee on lumber standards. While a different system of basic grades was recommended from that worked out at the Forest Products Laboratory, the action taken was a long step toward acceptance of the principles advocated by the Forest Service.

Logging and milling studies by the laboratory are proceeding region by region to determine the margin between costs and returns from forest by-products, consisting of small and top logs and mill edgings and trimmings. If the utilization of such items can be shown to yield even a small profit, forestry practice, particularly on private holdings, will be facilitated. Studies are well under way toward an evaluation of the losses that occur so commonly in small mill operations in the short-leaf pine region, and may be expected to increase the efficiency of such plants in that region. In the northern hardwoods work thus far indicates that trees smaller than 12 to 14 inches in diameter are frequently cut at a loss, which could be turned to a profit if the trees were left for a later cut. Under selective logging in northern hardwoods the indications are that the highest return per thousand feet is obtained under cutting to a diameter limit of approximately 18 inches.

A survey of woods waste in 11 logging camps of the Douglas fir region in the Pacific Northwest yielded very interesting results. The smallest amount of material found on a single acre of logged-off land was 6,916 board feet and the largest amount on an acre 52,235 board feet. The average amount of woods waste per acre for the company leaving the least material on the ground was 10,450 board feet, or 11.1 per cent of the original stand; and for the company leaving the most material, 33,107 board feet, or 37.7 per cent, of the original stand. The average amount of woods waste per acre for the 11 companies was 20,599 board feet, or 20.7 per cent of the original stand. The material left in the woods was classified into three grades of saw logs, cordwood, pulp wood, shingle bolts, poles, and piling, together with waste in high stumps, trees left standing which will be destroyed, and sound material in standing snags. The information on woods waste derived from this survey gives some idea of the immense field for research in developing methods of utilizing what is at present largely unavoidable waste.

Within the last year attention has been given to the treatment of lumber suitable for the home builder's use and to arrangements for marketing it through retail lumber dealers. This is but the beginning of a movement which promises to develop a new field for treated wood and to bring important benefits to the consumer as well as to those who manufacture and sell the treated lumber. Up to the present the wood-preserving industry has confined its attention almost entirely to the treatment of wood in large quantities, chiefly for the use of railroads and other large consumers. It has been practically impossible for anyone to purchase a small quantity of lumber thoroughly impregnated with a preservative against decay and insects, both of which are of great economic importance and destroy large quantities of lumber annually.

Tests of the mechanical properties of Alaskan woods showed these woods to be equal in strength to the same species grown elsewhere. A bulletin is to be prepared on Alaskan woods to aid in their utilization.

In the study of second-growth southern pines it has become apparent that the weight or density of the wood of young trees can be controlled by regulating the crown development. The study has demonstrated that it is possible to produce just as dense southern-pine timber in second-growth stands as is found in the virgin forests. When the proper silvicultural methods have been worked out, it will be possible for the forester to determine

in advance the type of wood best suited to the soil or a given site and to produce wood predominantly of this type.

Experiments were begun in the grafting of highly figured black walnut stock on ordinary black walnut seedlings to ascertain whether trees with figured wood may be produced in this way. The production of trees containing a high proportion of figured wood would greatly increase the value of future walnut growth in farm wood lots.

Shipping containers continue to require a large part of the annual cut of timber and afford an excellent medium through which to effect economies in utilization. Studies of the wire-bound type of box have resulted in the development of a box-designer's chart, whose use commercially will in many cases save material or reduce breakage in wire-bound boxes. Preliminary experiments point to the possibility of substituting low-grade resawed lumber for the clear quality rotary-cut veneer now commonly used in the wire-bound box.

Studies carried out in cooperation with the Bureau of Aeronautics of the Navy Department have yielded valuable data for use in aircraft design, on the bearing strength of wood under steel bolts, and the lateral buckling and twisting of deep beams. A manual was prepared for inspectors of airplane lumber and wooden airplane parts presenting the special instructions required for properly judging the properties of wood and for selecting stock suitable for airplane manufacture. A bulletin for the general public on the identification of woods used in furniture was prepared and published.

In further applications of colloid technique to the structure of wood, a rapid and accurate method has been developed for determining the minimum, average, and maximum lengths of the fibers of different species of wood. It has also been possible to determine the average and maximum sizes of the openings between the tracheids of wood. The average is about one-tenth of the smallest openings which can be seen with the highest-powered microscope, while the maximum is very close to the smallest size which can be seen microscopically. This information should be of value in connection with the impregnation of wood with liquids. The lignin in wood, which was previously shown to occupy both the middle lamella and the cell wall, has been more accurately divided and about 50 per cent is found to exist in each place. The lignins as thus separated were shown to be slightly different chemically.

Improved methods of operation and control of the sulphite pulping process as developed by the laboratory have been important factors in making possible the use of that process on hardwoods. Hardwoods have heretofore been pulped almost exclusively by the soda process. Laboratory and mill tests have shown that higher yields and better qualities of pulp, at least for some purposes, can be obtained by the sulphite process.

Two plants were installed and placed in operation during the year to produce pulp by the laboratory's newly developed semichemical process. One plant is converting gumwood into light-colored wrappings and the other is converting waste coniferous wood into pulp for use in container board. The rod mill, first applied to the pulp and paper industry by the laboratory, is an essential factor in the success of the semichemical process. It is proving of value also in refining screenings from chemical pulp mills and in beating chemical pulps. Numerous commercial installations during the year have demonstrated the practical value of the mill for those purposes.

Noteworthy advances have been made in the method of measuring the color of bleached pulps and in the interpretation of data thus obtained. The published results of this study have been very favorably received by the industry.

The work of the National Committee on Wood Utilization, under the leadership of the Department of Commerce, has been helpful in aiding to bring into commercial practice the findings of the Forest Products Laboratory that make for the more effective utilization of wood.

RANGE RESEARCH

A scientific basis for grazing timber and range land is essential. It is especially urgent where watershed conditions are easily altered. Grazing could not be eliminated from these watersheds without practical ruin to the western range livestock industry. The 36,000,000 cattle, horses, mules, sheep, goats, and swine in the 11 far Western States obtain nearly 70 per cent of their yearly feed from range land, largely the source of irrigation waters and municipal water supplies.

The watershed problem is especially critical in the Southwest, where the

vegetation at best is sparse, where drought may cause this meager vegetative cover to be reduced by a half or more in one year, and where overgrazing may cause extreme range depletion as well as an enormous amount of erosion. The 12 years' intensive study of the relation of herbaceous vegetation to surface run-off and erosion on high mountain watersheds at the Great Basin Experiment Station in Utah has shown the importance of maintaining as dense a vegetative cover as possible. Properly controlled grazing not only will not injure such watersheds when the vegetation is in good condition but may aid in their further improvement.

The half million acres or more of timberland in the Southwest on which satisfactory timber regeneration has been prevented or retarded by improper grazing call for research to determine specifically how timber and grazing use may be best combined and adjusted to each other. The forage conditions on the ranges of the Southwest in themselves demand attention. Drought and overstocking have seriously depleted much of the forage growth. Research on the semidesert yearlong cattle ranges at the Santa Rita Range Reserve in southern Arizona has developed improved range and livestock methods, enabling a sustained production of forage and livestock and a net profit of approximately 7.4 per cent through the recent trying years. Research can be of similar aid in improving grazing practices for all types of range.

Range research is responsible for the development of the deferred and rotation system of grazing; for open herding and the bedding out ("blanket") system of handling sheep; for improved practices with respect to salting, range water development and distribution, grazing periods, range utilization, and determination of the seasonal readiness of range plants for grazing; for methods of eradicating larkspur and other poisonous range plants; and for palatability studies of range plants which have furnished a sounder basis for determining carrying capacity and overgrazing. All of these improved practices are materially enhancing the productivity of national forest ranges and have increased the financial returns to the livestock industry greatly in excess of the money expended for research.

The work of the year in range research included completion of a manuscript covering the essential features of proper utilization of the important western browse plants. Studies of the western range herbaceous plants and of regionally important range plants, having the same end in view, are being continued. The results of over 15 years' study of artificial reseeding of high mountain range lands were prepared for publication. While the cost of seeding most cultivated forage plants on the range is ordinarily not justified, Kentucky and Canada bluegrasses, smooth brome, timothy, and orchard grass give some promise on depleted range areas where soil and moisture conditions are unusually favorable. Several native forage plants, especially violet wheatgrass and mountain brome, have given excellent results in artificial reseeding, but the lack of an adequate supply of seed precludes their extensive use now.

A manuscript was prepared covering a study of range utilization in its relation to maintained forage production and the production and marketing of livestock. Better utilization practices would assure greater unit production, better development of animals, and increased profits. Study of the utilization of mountain brush lands in Utah as summer range for cattle showed that brush areas can not profitably be stocked on the basis of reasonably full use of the oak, but that their use must be based upon proper grazing of the more palatable plants.

Analysis of the 10-year record of cost of producing cattle on the Jornada Range Reserve in southern New Mexico showed that conservation of the range and conservative stocking stand out as the prime factors in profitable cattle production in the region. Good range conditions are reflected in the condition of cattle, high calf crops, and low losses, considering the exceptional drought conditions which prevailed during most of the period.

During the coming year the aim will be to bring about a greater correlation between range research and other forest research, to complete the analysis for publication of a number of important studies which have been under way for several years, and to intensify those investigations which offer greatest possibilities for improving range conditions and increasing profits and stability for the livestock industry.

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GRAIN FUTURES ADMINISTRATION

No report published

for 1927

REPORT OF THE CHIEF OF THE BUREAU OF HOME ECONOMICS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF HOME ECONOMICS,
Washington, D. C., September 1, 1927.

SIR: I have the honor to present herewith the report of the Bureau of Home Economics for the fiscal year ended June 30, 1927.

LOUISE STANLEY, *Chief.*

Hon. WILLIAM M. JARDINE,
Secretary of Agriculture.

The fourth year of the Bureau of Home Economics was completed on June 30, 1927. The investigational work in foods and nutrition, textiles and clothing, and economic problems has been organized on the basis of projects which must by their nature extend over several years. This report is therefore largely a statement of progress. In the cases where these studies have been under way sufficiently long to yield definite results, they have been issued in the form of research bulletins and papers. The increasing demand for these publications indicates the widespread need for more extensive research in home economics.

During the year a total of $127,244 was available. The increase of $10,000 over the preceding year was appropriated for an expansion of the dietary studies. This made it possible to double the amount of work on this project. Still more rapid expansion of these studies is necessary if the bureau is to be in a position to help farmers adjust their production program to the nutritive needs of the public.

These studies of dietary habits, with analyses to find how completely the foods consumed meet the nutritive needs of the individual or the group, are of twofold significance. They furnish information for the guidance of production and also form the basis for educational programs of nutrition agencies. The influence of such accredited agencies in molding good food habits is too well recognized to require comment. Certain it is that never was such work more needed than at the present time, when much misinformation about food is being widely circulated by food faddists.

There is also need for home economics cooperation in studies of marketing methods with the idea of reducing costs and supplying products to the home maker in the form most satisfactory for her use. This will involve a study of costs of different containers and sizes most satisfactory for household use.

There has been little opportunity for the establishment of new projects or, in many cases, for the desirable development of those under way. Every effort has been made, however, to direct the work into the most-needed channels. For example, as the result of the emergency situation in the cotton market many of the studies already started on textiles have been centered on cotton. Data are being collected on the reasons for the decrease in the use of cotton materials in the home, and recommendations are being drawn up to aid in the better adaptation of standard fabrics to consumer needs.

Following the same plan, the major effort in publicity has been the radio releases prepared in cooperation with the office of information. In these, facts on meal planning, food preparation, clothing selection, budgets, and other subjects studied by the bureau have been restated in popular form that has reached thousands of home makers who were heretofore unfamiliar with the work of the depart-

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ment but who were eager for just this sort of information. This service has increased the distribution of publications and has almost doubled the requests for information coming to the bureau.

Whenever possible, the bureau has cooperated with other agencies, thus seeking to increase the effectiveness of its limited funds and facilities. Arrangements have been entered into with local representatives of the Society for Electrical Development and the National Association of Ice Industries to extend the research in household refrigeration. The rapid development of electrical equipment for the home has brought a multitude of questions to the bureau. Many of these involve investigation which must be done by the industries concerned. If the point of view of the consumer is to be adequately represented, however, it is necessary for agencies well acquainted with the general problems of home making to have a prominent place in this research.

Representatives of the bureau have been active in the development of a plan for establishment in Washington of a center for child study and parent education. Funds have been obtained from a foundation and will be administered through the American Home Economics Association. As one of the cooperating agencies in this enterprise, this bureau will assist in the research program on the nutrition, clothing, and care of the preschool child.

Close touch has been kept with the home economics divisions of the land-grant colleges and help given not only in the development of national projects but also on local problems. Bibliographies and outlines have been furnished whenever possible.

PERSONNEL

The bureau suffered great loss in the death of Caroline L. Hunt, since 1909 an outstanding member of the scientific staff of the department. Miss Hunt's broad fundamental training and philosophical point of view made her a valuable contributor to the bulletins on home economics, many of which carry her name and bear tribute to years of faithful service. Her kindly spirit and wealth of human sympathy endeared her to all who came in touch with her.

Aside from this loss, there have been few changes in the scientific staff during the year. All increases in personnel have been in the clerical and subprofessional grades so as to add to the efficiency and output of the scientific staff. As projects develop there will be a greater need for service of this grade.

Increasing use has been made of student assistants from George Washington University and University of Maryland. This service will, if possible, be extended to other institutions wishing to send students for limited periods to work on special problems which the bureau is particularly well qualified to handle. Research workers from some of the land-grant colleges have also taken advantage of the equipment afforded by our laboratories.

FOOD AND NUTRITION

No new projects have been started in this division, and some of the investigations have been discontinued or curtailed in order to concentrate on the more pressing problems.

CHEMICAL COMPOSITION OF FOODS

Considerable progress has been made in the collection of data assembled for a revision of Office of Experiment Stations Bulletin 28, entitled "Chemical Composition of American Food Materials." The demand for up-to-date figures on food composition is so great that it has been decided to publish the new data in sections as soon as each is complete. Figures on the proximate composition of beef have accordingly been issued and data on other meats will be ready for publication in the near future.

The compilation of figures on fresh fruits and vegetables is also nearing completion. In many cases published data were so few that little tendency toward uniformity in composition of a particular food was apparent. By obtaining authentic unpublished analyses from the Bureaus of Chemistry and Plant Industry, from State experiment stations, from university laboratories, and in a few cases from commercial organizations, it has been possible to supplement the data so that average figures on the proximate composition of some of these foods show very small probable errors.

The reported figures on refuse in vegetables varied so widely that laboratory studies were started to show what factors influence this variation. Since many dietary computations are based on the weight of the food as purchased, further studies of the waste in preparation of food, both in institutions and in homes, are needed. It is

hoped that a plan can be developed by means of which many of these data can be collected as a part of the routine work of the institutions.

The increasing recognition of the importance of mineral constituents makes desirable the collection of data on mineral content of food, but this can not be done with the present staff.

VITAMIN STUDIES

The work on the vitamin content of foods has been continued. Methods for testing for vitamins A and D are being developed which will make it possible to avoid some of the difficulties arising from the close relationship of these vitamins. The mercury-vapor quartz lamp is used in supplying vitamin D to the vitamin-A-free basal diet.

Continuation of the experiments on lettuce has shown that the bleached leaves from the head proper contain as much vitamin B and vitamin C as the outer green leaves. The outer leaves contain on the average about thirty-two to forty times as much vitamin A as the inner leaves. Lettuce does not contain vitamin D as indicated by the line test technic of McCollum.

The determination of the vitamin A content and calcifying properties of a commercial cod-liver-oil extract has been completed. This was carried out in direct comparison with a good grade of cod-liver oil so that it was possible to judge of the value of the extract as a substitute for cod-liver oil. In this study technic for the line test has been worked out so that the calcifying properties of foods can be compared quantitatively with a fair degree of accuracy.

Two samples of honey, one of very light color and the other of very dark color, showed no evidence of the presence of vitamins A, B, C, or D. A sample of honeycomb yielded similar results.

For demonstration purposes, series or rats have been fed in such a way as to show the effects of various deficiencies in the diet. Photographs have been taken for use in a set of charts now in preparation.

COOKING MEAT FOR PALATABILITY TESTS

This bureau has continued its cooperation with the Bureau of Animal Industry and the State experiment stations in the national project on factors which affect the quality and palatability of meat. The contribution of this bureau has been along the following lines: The best standard methods for cooking the different kinds of meat, cooking cuts of known history by the standard method for the palatability test, study of specific problems arising in the adaptation of the standard method to home uses, and collection of data on the color of raw and cooked meats.

In developing standard methods the aim was evenly cooked meat with a maximum of juice and natural flavor. From a practical point of view it was essential to keep the time required for cooking to the minimum necessary for successful accomplishment of this purpose. The experimental cooking has included work on beef, lamb, cured pork, and veal. The major emphasis was on lamb and the work on the other meats supplementary to that done by other laboratories cooperating in this project. In the studies on lamb, legs, shoulders, and breasts were used as far as possible in pairs from the same animal for comparison. These were planned to show the effect of varying oven temperatures and the temperature of doneness, and of the removal of the fell. The results of these experiments in the cooking of lamb are the basis of the method for roasting lamb adopted by the committee in charge of this phase of the work on the national project.

One hundred and fifty-four rib roasts of beef from 14 States, 165 legs of lamb from 6 States, and 14 cuts of fresh pork, all from experimentally fed animals, were cooked according to standard directions and judged for palatability. The data from these experiments have been sent to the Bureau of Animal Industry to be correlated with production factors and other determinations. One or more members of the staff have served on the committee testing the palatability of meat, and have cooperated in the revision of the score card.

In applying the results of this experimental cooking of meat to home use, additional problems have arisen. Such questions as initial searing of the roast, oven temperatures, and the most efficient use of electric ovens are being given special attention.

DEVELOPMENT OF RECIPES

Some 300 recipes were developed, tested, or modified for use in the radio and other publicity services. Special attention was given to short cooking of vegetables which conserves the min-

eral and vitamin content. So far as possible, requests for special recipes were met and recipes sent in by radio listeners were tested and included in succeeding releases if they were of broad enough application.

Over 100 dishes were prepared for photographs and models to be used in exhibits, bulletins, posters, and press releases. Much of this work is done at the request of other bureaus and requires considerable time. A series of suggestions and recipes for the use of Neufchatel and cream cheese was worked out at the request of the Bureau of Dairy Industry for the revision of the bulletin dealing with the manufacture and use of these types of cheese.

Brief studies were undertaken to show when the so-called waterless cooking is an advantage and how it can be carried on with the utensils generally found in the home kitchen.

Quantity recipes are being developed, with special attention to those most desirable for school lunches, nursery schools, and day nurseries.

HOME PRESERVATION OF FOOD

Continuing studies on home canning, blackberries and beets were canned in glass and tin for further observation of color changes. The results from canning whole wheat and suet pudding in the pressure cooker were checked and the directions altered accordingly. Work on canning asparagus has been continued in order to check the most desirable times and temperatures.

The lamb canned last year with and without added fat was opened and scored. All had been hot packed and processed in a pressure cooker at 15 pounds pressure for a minimum of 50 minutes. There was no spoilage in either lot. The method recommended for canning lamb has been written up for inclusion in the revision of the bulletin on the butchering and use of lamb on the farm, which will be issued jointly by this bureau and the Bureau of Animal Industry.

In cooperation with the Bureau of Plant Industry, some special studies were made of the suitability of different varieties of strawberries for preserves. In connection with this a comparison was made of the different home methods of preserving strawberries.

A study of the pickle recipes being suggested for home use indicated that an analysis and simplification of these was desirable. Using the methods suggested by the Bureau of Chemistry, vegetables were fermented and brined under conditions comparable to those found in the home and combined into various pickle mixtures. Special attention has been paid to desirable combinations of spice, vinegar, and sugar, and to methods which would insure a crisp product with a minimum of spoilage. Many of the old-fashioned pickle recipes yield a product which will not keep in the storage places provided in the modern heated house. When the product is processed to insure keeping, unless the operation is carefully controlled, the material softens. Typical pickles have been prepared and submitted to various individuals for scoring. These have been held over the year for observations on keeping quality. It is proposed to mimeograph these recipes and send them out through the extension service for further testing and comment. The final results will be brought together in bulletin form.

HOUSEHOLD REFRIGERATION STUDIES

The study of household refrigeration begun last year on one electrical unit lent by the manufacturers has been continued. Records of the temperature of the room and certain points in the box, the current consumed, and the periods of the operation of the motor are now being analyzed. Most of the time the food chambers were empty, but during certain periods large quantities of meat were stored. Through a cooperative arrangement with manufacturers of both mechanical and ice refrigerators, as well as with the ice industry, more extensive research will be undertaken the coming year.

ECONOMIC STUDIES

FOOD CONSUMPTION OF FAMILIES

The data for a study of the diet of farm families are taken from the schedules of the survey of farm standards of living made jointly by the Bureaus of Agricultural Economics and of Home Economics. The average quantity and value of each foodstuff consumed by farm families have been determined for 840 farm families. The nutritive value of these average diets has been calculated in terms of calories, protein, calcium, phosphorus, and iron, and the distribution of the total calories and the total value among the various fuel groups has been shown. Similar data are now available for 2,677 families in nine States.

Two preliminary reports on these results have been issued, one for 1,331 farm families in Kansas, Kentucky, Missouri, and Ohio, and one for 86 farm families in Vermont. For 382 families in Ohio, the diet of each family has been analyzed from the standpoint of nutritive value and money value and the relation of these to the amount of food furnished by the farm. This brings the total number of individual family dietaries analyzed to 1,253. A bulletin is now being prepared which will embody the results of the analyses of all the individual family dietaries.

A summary was prepared last year bringing together in tabular form data on previous food-consumption studies made in the United States. The demand for this material has been such that it will be extended, and the essential points published in connection with the bulletin on food habits of farm families.

DIETARY SCALES AND STANDARDS

In analyzing a diet for adequacy it is necessary to have a standard measure of the amount of food needed per adult-male unit and a scale by means of which the family needs may be expressed in terms of such a unit. In the summary of dietary studies it was found that no less than five such scales and standards have been in use in the United States. Analysis of these reveals inconsistencies, and their use makes a comparison of results from different studies difficult if not impossible.

A detailed study has been made of these dietary scales and standards, which was published in the technical bulletin series of the department. A new double scale is proposed which embodies the more recent findings from investigations in nutrition. This scale will be used in the further studies of dietary habits made by this bureau.

METHODS OF COLLECTING DATA ON FOOD HABITS

At the conference on dietary habits called by the bureau in April, 1926, the question was raised as to the comparative value of the different methods of collecting data for these studies. This question was further considered at a meeting of representatives of various organizations at Minneapolis in June, 1926, and an outline prepared for a proposed cooperative study. It was the opinion of this group that more data needed to be collected before a national committee could function effectively. The following studies have been initiated in order to furnish this:

The accounting method is being used by a number of colleges and universities for collecting data on food consumption of individual families or of institutional groups. A comparison of the results obtained by the accounting and by the survey method of collecting food-consumption data will be made. It will be based on about 200 account books which are being kept this year and upon that many or more records collected by the survey method. Material may also be used from the dietary survey made by the Office of Home Economics in 1917–18 and from the records of workingmen's families collected by the Bureau of Labor Statistics in 1918–19. Besides the method study, some interesting figures on the food consumption of families at the minimum, families of skilled workmen, families of professional and business men, and farm families will be obtained from this material.

Under the Purnell Act a number of studies are being made in which the food-consumption data are of a qualitative nature. In many of them the nutritive condition of the individual is ascertained, and this is correlated with the individual's food habits. Studies of that kind open up many questions that need investigating, such as criteria for evaluating the diet and for ascertaining the nutritive condition of the individual, and suitable statistical methods of studying such a correlation. An investigation of this kind is now under way. The data collected by the Children's Bureau of the United States Department of Labor are being used for this qualitative study. Quantitative material collected in Mississippi will be used for comparison with the results obtained by the qualitative method of studying food habits.

CLOTHING EXPENDITURES OF FARM FAMILIES

The work of analyzing the data on clothing expenditures of farm families obtained from the survey of farm standards of living has been continued. A preliminary report on the average clothing expenditure of 86 farm families of Franklin County, Vt., during 1923–24 has been issued. This report shows the expenditures for each article of clothing purchased during the year for husbands and wives and for sons and daughters of seven different

age groups. There is also shown the average number of persons purchasing each garment, the average number of articles of each kind purchased per person, and the average cost of each article.

For 2,010 farm families from 7 States material has been analyzed to show the total yearly expenditure for clothing for each of 15 age and sex groups and the relative expenditure for each group in terms of the husband's expenditure, and also the distribution of the total expenditures among 6 different classes of clothing. The average number and cost of home-made and of purchased garments for each of the four value-of-living groups and for all groups combined has been ascertained for 728 farm families.

TRENDS IN COTTON CONSUMPTION

A study of the changes over the past five years in consumer-demand for cotton in clothing and in household articles, and of the reasons for the changes, had been undertaken as a part of the program of the department to aid the situation in the cotton market. Data are being collected from all available printed material, by letters to various organizations, by interviews, but chiefly by a questionnaire circulated to consumers through the extension service, home economics departments in colleges, universities, and high schools, and through women's clubs. To date some 650 questionnaires have been received, and several hundred more are promised.

HOUSEHOLD ACCOUNTS AND BUDGETS

A number of alternate forms for planning and recording family expenditures were prepared and tested out with farm and with city home makers. The results have been embodied in an account book for family expenditures and a bulletin illustrating and explaining several methods and forms for planning and recording family expenditures. Both of these have been submitted for publication.

Most of the data on family expenditures so far collected by various agencies have been obtained by the survey method. While it is recognized that some error must be present in such figures, the extent and nature of this error are not known. Before collecting new data on family expenditures, therefore, it has seemed desirable to compare the figures obtained by the survey schedule with those obtained from accounts kept by home makers.

Plans and blanks for such a study were drawn up and were first used in July, 1926, with a group of 50 farm home makers in Maryland. Survey schedules were taken for all the families for the year 1925–26. Twenty-five of these home makers began keeping itemized accounts and sending in weekly records. Twenty-two of these home makers finished the complete 12 months on June 30, 1927. Survey schedules will be taken for the 50 families for the year 1926–27. Comparisons will then be made between the four sets of survey schedules (account and nonaccount keeping families for 1925–26, and for 1926–27) and the account books.

Similar data have been obtained for five farm families in Ohio. Account books have been obtained for 30 families in Illinois, and it is expected that survey schedules will be obtained from the same 30 families and, if possible, from 30 comparable but nonaccount-keeping families at the close of the account year (January-March, 1928). Through the Bureau of Welfare of the District of Columbia, division of mothers' pensions, 90 family account books will be available between November 1, 1927, and January 31, 1928. These will be compared with survey schedules taken for 1927 from these or comparable families. It is expected that comparable survey schedules will be obtained from members of the trades in Washington, D. C.

During this year 76 professional and business families in various parts of the United States have been keeping detailed accounts and sending in weekly reports. Survey schedules from comparable families will be obtained during the summer of 1927 from the women attending the Vassar Institute of Euthenics, through graduate students at Columbia University, and through the home-economics departments of other colleges and universities. Survey schedules will also be obtained from some of the account-keeping home makers in 1928. This will give data upon which a comparison of the survey and accounts methods may be made for four different classes of American families, based on some 253 account books and about twice that number of survey schedules.

Studies on suggested budgets for farm families and expenditure scales for farm families by age and sex are being continued. These will be published as soon as sufficient data have been collected to assure representative figures.

USE OF TIME BY HOME MAKERS

Weekly time records from over 500 home makers are now on hand, and a total of about 500 more have been obtained by Purnell workers in the four States which are cooperating. The editing and classifying of these records is being pushed as rapidly as possible. Detailed directions for all of this work are now complete, and copies have been sent to the Purnell workers in Oregon, Washington, and Rhode Island who are classifying the records which they have taken. The results from these States will thus be comparable with those of the bureau. The records obtained by the Purnell worker in Idaho have been sent to the bureau for classifying and for use in its reports.

Of the 500 records about 300 are from farm homes and 200 from town and city homes. One hundred additional records from farm women are expected within the next few months, and a report on the farm records will then be made. A trial analysis of the first 100 farm records indicates that about 400 are necessary before averages can be made and conclusions drawn. Since comparisons can be made between these 400 records and the similar number obtained by the three Purnell workers, it is probable that a still larger number of farm records will not be needed.

The analysis of the results from town and city home makers will not be started until several hundred additional records have been received and classified. Owing to the great variety of the homes from which these records come, it will doubtless be necessary to break them into two or more groups, each group including several hundred home makers. It is hoped that enough records can be obtained and classified during the year from one of these groups to justify a report.

ECONOMIC VALUE OF HOME MAKER'S TIME

One of the questions concerning the home maker's job which has repeatedly appeared during the last few years is what her time is worth in dollars and cents when spent on her various tasks. Answers to this question would undoubtedly encourage a greater appreciation of the value of the home maker's work, and, more significantly, they would give her a more definite basis for choosing the tasks on which she will spend her time. Every home maker in this industrial age is constantly deciding whether to do her own baking, canning, sewing, laundering, or cleaning or to have this particular task done for her by hired help or by an outside agency while she spends her time on some other work. At present she has little or no information as to the comparative economic value of her time when spent in these various tasks.

In placing an economic value on the home maker's time, the cost of a paid substitute for her unpaid labor must, of course, be used. Two types of substitutes are available—one the services of the paid worker in the home and the other the services or goods of the agency which performs the same task outside of the home.

During the past year a study has been started using the second type of substitute. The cooperation of a small group of Washington home makers was obtained, the blanks were provided upon which they recorded the time and money costs of doing a given task in their homes and also the amount of money and of their time which would have been required had they purchased articles or services of similar quality outside. The studies were made by the home makers during the regular course of their housekeeping, and reports were obtained covering 15 tasks. The variation shown in the value of their time was very great, ranging from almost nothing to over $2 an hour. Seven of the studies gave a value of less than 50 cents an hour, seven a value of from 50 cents to $1 an hour, four of from $1 to $2, and four of over $2.

On the basis of the experience with these home makers, the plans and blanks for the study were revised, and sets have been sent to a number of extension and college workers. Further cooperation of this sort will be sought during the coming year, emphasis being placed, as far as is consistent with the needs of the State workers, on tasks which are relatively standardized and frequently done by home makers, such as bread baking and certain canning and sewing jobs.

A large number of studies from different home makers will, of course, be needed before any conclusions can be reached, and these results will probably need to be supplemented by studies under controlled conditions in a home or laboratory.

The second method of placing money value on the home maker's time, in which the cost of the paid worker in the home is used, will more readily yield results. For this evaluation two

sets of figures are required—one the hours spent by the home maker per week or year on each kind of task and the other the hourly wage or salary rate paid to each kind of hired domestic worker. The first set of figures will be available during the year from the study of the present use of time by home makers. The figures on wage and salary rates will be obtained from employment agencies and from home makers. The workers for whom the rates of pay are obtained must, of course, compare as closely as possible in quality and speed of work with the type of home maker for whom the evaluation is being made.

TEXTILES AND CLOTHING

UTILIZATION OF COTTON FABRICS

In view of the serious cotton situation, a study has been made of the cotton fabrics on the market with a view to suggesting ways in which they could be modified so as to meet better the needs of the consumer. Conferences were held with pattern companies, advertising agencies, commission men, and representatives of commercial textile organizations as well as with home economists. The results have shown that design is the dominant element in the consumers' estimate of the value of fabrics at the present time, and, if cotton fabrics are to be used extensively, design must be given more attention. The force of education becomes greater every year, the opportunities to develop taste increase, and the textile producer who does not develop artistic fabric designs as well as new ways of using standard materials will lose opportunity for profit and for service.

If the situation is to be adequately met from a national point of view, much research must soon be undertaken. The following are some of the most outstanding questions for investigation: Commercial factors influencing costume design and silhouette; styling of fabric design and the relation of fabric and yardage requirement to costume design and silhouette; present manufacturing problems in the development of fabric design and the most effective ways of increasing interest in the better design and styling of cotton fabrics; mediums through which adequate information may be distributed to consumers in regard to the merits and effective use of cotton. This should include an analysis of the different policies used by retail groups to sell and advertise cotton fabrics with emphasis upon the relation of these to consumer-purchasing habits. The results of such a study could be made effective through cooperation with agencies training in retail selling. Studies should also be made of the organization of methods of marketing and the national advertising of cotton fabrics. Such an investigation would do much to contribute to a better understanding and solution of some of the intricate problems now existing in the industry.

During the past season a preliminary study was made of the adaptability of American-made cotton fabrics to dresses designed in accordance with the present vogue. Appropriate dress designs for various types of figures were developed and carried out in cotton dresses. These dresses are to be used for exhibit purposes, and photographs of them are being distributed through publicity channels.

The models used in the Sesquicentennial exhibits to show appropriate and inappropriate costume design brought many requests for similar traveling exhibits. Sets are, therefore, being made and will be lent through the Office of Cooperative Extension Work. These also emphasize the use of cotton in clothing. Another exhibit is being prepared showing the most attractive ways of using cotton for household purposes.

FABRIC FINISHING

Studies on the refinishing of cotton fabrics in home laundering so as to simulate more nearly the original finish have been continued from last year. Sizing mixtures of various compositions have been studied with particular attention to the use of American agricultural products. For instance, at the request of the Bureau of Plant Industry, tests were made on rice starch and dasheen starch with the hope of extending their use in the textile industry and in home laundering. Throughout all this work it has been necessary to develop laboratory methods, since the terms applied to the properties of sizes and sized material have been very vaguely defined and no methods of measuring them worked out. Particular attention has been given to methods of determining the stiffness and pliability of sized fabrics.

The final experimental work on stiffness has been completed. Formulas using various kinds and quantities of starch and foreign ingredients have been studied as well as the effect of

varying the concentration of the mixture and the time of cooking. The mathematical interpretation of the data is now under way.

An instrument for testing the pliability of starch films has been developed and is being tried and improved. This has been standardized by means of cellophane strips. Investigation of the various methods of measuring the thickness of these films has also been made.

In connection with the studies on cotton, an investigation has been made of different cotton fabrics after laundering to determine the effect of washing on the original finish and the possibility of reproducing this finish with the aid of household mechanical devices. The formulas developed by the sizing studies were used and investigations made of the effects produced by varying the temperature, pressure, and padding of rolls on an electric ironer. The results obtained by these methods were compared with those produced by stretching devices. This work is still under way.

LAUNDERING

The investigations on the most effective temperature for the removal of soil from textile fabrics have also been continued from last year. An experimental washer for this work has been planned and built. The studies on the composition of the artificial soiling mixture to be used have been completed, as well as the series of experiments made to determine the type of fabric best suited for this work. Additional studies were made of methods of desizing cotton materials, and these will be continued as a separate project.

Studies of the scorching temperature of textile fabrics during the process of ironing are also in progress. As a part of the preliminary work of this project investigations have been made of various methods of determining the amount of chemical decomposition which cotton fabrics have undergone when ironed at too high a temperature. The use of the viscosity of cuprammonium solutions, of copper numbers, and of the alkali solubility of partially decomposed cotton has been studied. It is hoped that this work can be carried forward during the coming year.

MODERN TRENDS IN HOME SEWING

The results of the study of the clothing practices of 1,981 women from 32 States have been compiled, and the report is in press. These show that nearly three-fourths of the women who reported were making nine or more kinds of garments for men, women, and children. As was expected, more of the women who are sewing at home live in the small, rather than in the larger communities. When grouped according to income, the women who did the most sewing fell in the $2,000 to $2,999 group rather than in the lower-income groups.

It was shown in a very striking fashion that fitting was one of the greatest difficulties these women encountered in making garments. Farmers' Bulletin 1530, Fitting Dresses and Blouses, was prepared and issued in order to assist in meeting this need. Another difficulty which was mentioned in a large number of cases was choosing becoming and practical designs. Ready-to-wear garments are popular largely because women can see how the completed garment looks on them.

CHILDREN'S CLOTHING

A study of the weight and kinds of garments being worn by children under 2 years of age in various parts of the country has been undertaken as a part of an extensive study of children's clothing. Data are being gathered during a typical summer and a typical winter month and an attempt is being made to discover the type and amount of clothing that is considered by practical experience to be the most satisfactory for different climatic conditions. Twelve home economics departments in various parts of the country are cooperating in this project. The clothing of 200 children was weighed and studied in Washington, D. C., last winter and a similar number will be reported during the summer.

The influence of clothing on the skin temperature of infants is being studied in order to obtain one measure of the comfort of infants dressed in fabrics of different composition and construction. The literature has been reviewed for this investigation, the preliminary experiments completed, and the apparatus to be used purchased and calibrated. It is planned to study the effect of wool, cotton, union, and rubberized fabrics on skin temperature.

A study of the designs of children's rompers as found in ready-made garments and patterns has been made. Approximately 60 different designs were included. These were analyzed from the standpoint of hygienic quali-

ties, comfort, ease of laundering, and adaptation to child training. Some of the results are embodied in a circular on children's rompers which has been submitted for publication.

As the result of conferences held with persons in charge of children's clothing in the various orphanages of the city and with interested mothers, a lantern slide set is being prepared which shows some of the most outstanding advantages and disadvantages of various types of children's garments. Approximately 300 photographs have been taken in the preparation of this set, and the project has resulted in the addition to the files of an excellent series of photographs of children's clothing which will be valuable in many connections.

THE RELATION OF CLOTHING TO HEALTH

As a part of the preliminary work looking to investigations in the relation of clothing to health, a bibliography of articles and books dealing with this subject is being compiled. Approximately 1,000 books and articles have been reviewed, and it is planned to include and annotate all that have scientific interest.

STUDIES IN WOOL

A popular bulletin on the selection of woolen fabrics is now in preparation and study will be made on the care of woolen garments. The importance of wool to agriculture and the manufacturing interests of this country is so marked that more attention should be given to the consumer's problems in the selection and care of such garments.

HISTORICAL BACKGROUND FOR HOME ECONOMICS

A collection is being made of historical material throwing light on the development of the home-economics movement. Since much of the work during the early period was associated with individuals, a series of 12 biographical papers has been prepared showing contributions to the scientific and philosophical background of home economics. So far as possible, this material will be issued as articles in journals or used for talks before groups of students.

INFORMATION AND EXHIBIT SERVICE

Radio releases have been the feature of the information service. A special writer of the staff of the office of information put into conversational form facts on foods and nutrition, clothing, and other home-economics topics furnished by the bureau. These releases, under the caption "Aunt Sammy's Household Chats," have been sent five times a week to about 25 stations for broadcasting. Judging by the letters that have come from broadcasters and home makers representing every State, the radio is one of the best possible ways of popularizing scientific facts on home problems. A total of 176 of these releases of approximately 1,500 words each have been distributed. In these have been included 300 tested recipes and 130 menus for well-balanced, appetizing meals that could be prepared easily and at moderate cost.

Technical and popular information has been sent out in the established channels as bulletins, articles for periodicals and scientific journals, and press items.

The following publications have been issued in the regular series of the department:

Stain removal from fabrics: Home methods. Division of Textiles and Clothing. Farmers' Bulletin 1474.
Convenient kitchens. Greta Grey. Farmers' Bulletin 1513.
Principles of window curtaining. Mary Aleen Davis. Farmers' Bulletin 1516.
Fitting dresses and blouses. Maude Campbell. Farmers' Bulletin 1530.
Dietary scales and standards for measuring a family's nutritive needs. Edith Hawley. Technical Bulletin 8.
Proximate composition of beef. Charlotte Chatfield. Department Circular 389.
Planning your family expenditures. Chase G. Woodhouse. Miscellaneous Circular 68.
Score cards for judging clothing selection and construction. Ruth O'Brien, Maude Campbell, and Mary Aleen Davis. Miscellaneous Circular 90.

Eight articles describing various types of work in the bureau were contributed to the Yearbook of Agriculture for 1926.

Manuscripts for three more bulletins and drawings for a series of charts on kitchen planning are ready for printing.

The distribution of free copies of the 27 bulletins of this bureau on various economics topics has totaled 2,129,946. This is exclusive of sales

through the Government Printing Office, which run well up in the thousands.

A bibliography on footwear was issued in mimeographed form, bringing together 200 references in English to books and periodical literature on the fitting of shoes, foot structure, corrective foot exercises, shoe history and design, the manufacture of shoes, hosiery, and shoe care and repair.

A selected list of Government publications on housing and equipment was also mimeographed for distribution as reference material for teachers and professional home economics workers.

The volume of material supplied to newspapers and magazines has increased by 50 items, making a total of 250 during the year. These include special articles written in response to editorial request, as well as brief items popularizing facts on food selection and preparation and the choice and use of fabrics in the household.

An exhibit of eight booths representing different phases of the work of the bureau was sent to the Sesquicentennial in Philadelphia for display during the summer and fall of 1926. Since then two of these booths dealing with foods and nutrition have been reconditioned and some new features added. At the request of the American Child Health Association and the American Medical Association, these booths were displayed for the benefit of delegates to the conventions of these two organizations meeting in Washington during the spring of 1927. At present this material is forming part of the department's exhibit at the Interstate Highways Exposition at Reno, Nev.

A booth entitled "The Kitchenette Steak" was planned by this bureau as one of the features of the International Livestock Exposition in Chicago in 1926. Two displays suggesting ways of cooking and serving poultry and poultry products have been prepared for the exhibit at the World Poultry Congress held this summer in Canada. Wax models of 19 kinds of these foods were made under the direction of the bureau from foods prepared here.

The exhibits of washing machines and sewing machines have been maintained, and advantageous contacts made with a large number of manufacturers. The ironing machine exhibit has been developed as far as space permits.

U. S. GOVERNMENT PRINTING OFFICE: 1927

REPORT OF THE INSECTICIDE AND FUNGICIDE BOARD

UNITED STATES DEPARTMENT OF AGRICULTURE,
INSECTICIDE AND FUNGICIDE BOARD,
Washington, D. C., June 30, 1927.

SIR: I have the honor to transmit herewith the report of the work of the Insecticide and Fungicide Board for the fiscal year ended June 30, 1927.

Respectfully,

J. K. HAYWOOD, *Chairman.*

Hon. W. M. JARDINE,
Secretary of Agriculture.

GENERAL REVIEW

The insecticide act of 1910 became a law on April 26, 1910. By its provisions it became effective on January 1, 1911. The Insecticide and Fungicide Board, an organization composed of four scientists selected from the Bureaus of Animal Industry, Plant Industry, Entomology, and Chemistry, was created to assist the Secretary of Agriculture in the discharge of the responsibility placed on him for the enforcement of the law. The board has been actively at work on this charge from the time of its formation until it ceased to exist on June 30, 1927, the work then being transferred to the Food, Drug, and Insecticide Administration. Two of the members of the board have served continuously for the more than 16 years of its existence, and a third member since 1912.

In the period since 1910 the insecticide and fungicide business has experienced a tremendous growth. It has developed from a side-line business to a highly specialized industry. The more common agricultural insecticides and fungicides have become very thoroughly standardized. The board has assisted in this work through constant watchfulness of the products on the market, through special campaigns against special products when they were found to be inferior or habitually misbranded, through basic investigations to assist the manufacturer in marketing a better and more uniform product, and through service and regulatory announcements which have been issued from time to time to give information to manufacturers.

A basic investigation of lead arsenate has been completed and the results published. They show under what conditions a satisfactory lead arsenate may be made, and explain, in most cases, why injury has occurred in the cases in which it has occurred and how such injury may be prevented in the future.

Calcium arsenate was not used commercially until about 1918. Now it is one of the most important insecticides, especially for use against the cotton-boll weevil. During the rapid expansion of the manufacture of this very complex material many difficulties were encountered. Many batches of it which would cause injury to cotton were put on the market and careful supervision was required. The board has carried on very complete studies

of calcium arsenates and has assisted manufacturers in standardizing their products. It has been found that for the most part the calcium arsenate now being manufactured is very satisfactory. The manufacturers have so perfected their manufacturing operations that nearly all the calcium arsenate now appearing on the domestic market is up to a satisfactory standard; i. e., contains a sufficient amount of total calcium arsenate to effectively control the weevil and does not contain an excess of water-soluble arsenic.

Investigations have also been made of pyrethrum powders, of chlorinated disinfectants, of nicotine dusts and soaps, and of other materials which have caused trouble either through difficulty in manufacture or through deterioration after manufacture. The results of these investigations have been published as departmental bulletins and in the scientific periodicals.

When the board was first organized the entomologists took up the problem of the so-called liquid lice killers which were claimed to control chicken lice when applied to the roosts and dropping boards. After a series of experiments, which covered several years, had demonstrated that such preparations were not effective against chicken lice, manufacturers of these so-called liquid lice killers were notified by the issuance of a service and regulatory announcement. This notice conveyed the fact that such preparations were not effective remedies against chicken lice and as a result practically all of these preparations have been withdrawn from the market.

One of the beneficial results of the activities of the board has been in giving to certain commercial products, such as Bordeaux mixture, definite meanings. Formerly the term "Bordeaux mixture" as applied to commercial fungicides meant a fungicide containing any copper content which the manufacturer saw fit for it to contain. The recommendation for the use of these mixtures was usually quite haphazard and the dilutions were such that they usually resulted in a very weak mixture. As a result the commercial Bordeaux mixtures were usually disappointing in their results when used for the control of plant diseases. As a result of the board's efforts Bordeaux mixtures now, when used as directed by the manufacturer, will not only be of the correct strength but will have the fungicidal powers usually possessed by a correctly made Bordeaux mixture. There has also been published under the auspices of the board a bulletin by means of which the user of Bordeaux mixture may determine the strength he desires by reference to tables.

Lime-sulphur solution and other of the more common fungicides have been similarly treated. Only those who use fungicides in large amounts each year can fully appreciate the great benefit accruing from this work. The correct statement by manufacturers of the uses and limitations of the various fungicides results in benefits to the users which must amount to immense sums each year.

While the older and more common agricultural insecticides and fungicides are well standardized, the insecticide and fungicide industry is constantly growing and constantly changing. As previously stated, calcium arsenate, practically unused before 1918, is now one of the most important insecticides. Lubricating-oil emulsions for use against scale insects have also shown a very large expansion in manufacture and use. The fluorides and fluosilicates have recently become important as insecticides, and copper carbonate and organic-mercury compounds have become important agricultural fungicides. Household insecticides, usually sold under proprietary names, are constantly changing. New products are constantly appearing on the market and old products are found to contain different ingredients. Proprietary disinfectants, too, are constantly changing, and the basis of disinfection, especially the relation of a disinfectant to use against a specific organism, is so little understood that a very considerable amount of investigation along those lines is necessary.

When new products appear on the market they are usually at first of varying composition, often injurious to the plants or animals on which they are to be used, and often recommended for uses for which they are not fitted. They require careful scientific investigation both for their control and for their improvement, so that they may become satisfactory, standardized, commercial products.

Since the organization of the board, samples from 17,538 shipments of commercial preparations have been collected and examined. All of these samples have been analyzed by chemists of the board and a large propor-

tion tested by the entomologists, pathologists, veterinarians, or bacteriologists, and in some cases by all four groups. In addition to considering each and every claim that appeared on the labels the board has tested and considered each separate ingredient found in the samples to determine the effect on insects and fungi, in order to pass on the question of active and inert ingredients as required by section 8 of the act. A large amount of testing also has been carried on to determine the effectiveness of many of the common insecticides and fungicides in different dilutions with various methods. As full and systematic records have been kept of the analyses and tests, the board has accumulated in its files an enormous amount of data that are available for the use of the Food, Drug, and Insecticide Administration (1) in considering labels for new preparations when these are submitted with the chemical analyses for criticism, (2) in estimating very closely the efficacy of a given preparation in advance of actual tests, (3) as collateral evidence at the trials of cases, (4) in support of charges based on expert testimony when tests with similar preparations have shown them to be inefficient, and (5) in taking quick action in advance of tests in those cases where immediate action is desired.

Each year since the inception of this regulatory work the board has covered the whole country fairly well with a very limited inspection force, and, in addition to the collection of samples and evidence of shipment, has obtained data which will be of exceptional value in perfecting a more thorough and comprehensive scheme of inspection which will be made possible by having the large force of inspectors operating under the Food, Drug, and Insecticide Administration available for insecticide act enforcement work.

It is believed that statistical data covering the period beginning July 1, 1911, and ending June 30, 1927, may be of value and interest at this time. During this period the board reported to the solicitor of the department 1,589 cases presenting alleged violations of the law, with recommendations that the facts be reported to the Attorney General to institute criminal action or seizure proceedings. Disposition was made of 2,819 cases by correspondence with the manufacturers. These cases presented violations which were technical only, not flagrant, or cases in which the manufacturer gave reasonable and adequate explanation of his failure to conform to the provisions of the act. Action was taken to place in abeyance 14,270 samples which upon examination and test were shown to be in compliance with the provisions of the law or were from shipments of the same goods made prior to shipments for which the manufacturer had been convicted or had, after citation, conformed to the requirements of the law. On June 30, 1927, 89 cases were pending preliminary hearings or before the board for final action, 265 were held in temporary abeyance pending the receipt of further information or the outcome of prosecution based on the same product or correspondence with the manufacturers, and 628 were undergoing analysis and test.

As has been pointed out in previous annual reports of the board, a statistical statement of the samples taken and examined, seizures made, prosecutions brought, etc., conveys practically no idea of the volume of work involved and the effect produced on the quality of products. The result of the enforcement of the law is that the farming communities in particular are receiving much higher grades of insecticides and fungicides and articles of much more standard composition than they were receiving previous to the enactment of the law. The confidence established by this work greatly encourages the manufacture and sale of legitimate materials and tends to encourage the use of these materials by farmers in preventing and combating diseases and insect pests of their crop plants and livestock.

The inspectors of the board operating throughout the United States collected samples from 15,242 shipments. A general classification of the articles represented in the collection is as follows:

INTERSTATE SAMPLES

Number of samples of insecticides and fungicides collected in stated years

Class of samples	Fiscal years																
	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	Total
Arsenate of calcium and boll-weevil preparations								39	102	98	24	33	30	38	45	21	430
Arsenate of lead	87	154	94	128	201	76	83	96	51	79	77	80	33	19	54	24	1,336
Bordeaux mixture and combinations of Bordeaux mixture with insecticides	29	48	53	77	87	63	63	118	79	73	62	51	45	29	45	33	955
Chlorinated lime				13	19	18	9	20	6	22	10	10	3	3	8	8	149
Cyanide preparations	2	3	8	9	3	4								12	7	3	51
Dips for animals	71	62	58	47	54	44	35	21	20	26	49	69	26	22	30	34	668
Disinfectants, germicides, bactericides		106	117	137	221	148	100	93	83	102	154	174	99	161	137	132	1,964
Fly preparations for animals	18	37	60	56	37	36	35	18	33	30	36	59	25	30	32	30	572
Fish-oil and whale-oil preparations	10	12	14	20	14	17	19	29	9	6	9	10	13	6	6	6	199
Formaldehyde preparations	20	15	11	10	24	12	7	16	8	15	8	38	8	11	10	9	222
Insect preparations, household use	30	116	130	102	190	156	119	82	52	101	115	202	170	164	193	214	2,136
Miscellaneous insecticide and fungicide preparations, agricultural use	8	15	14	10	16	96	47	90	97	58	94	172	71	91	150	149	1,178
Lice and mite killers	75	73	54	89	102	83	48	41	32	57	61	58	91	102	83	80	1,129
Lime-sulphur solution and sulphur preparations	21	48	50	69	103	51	46	38	32	50	41	68	42	41	54	48	802
Nicotine preparations	25	37	51	27	39	23	17	3	6	7	31	34	22	25	22	17	386
Paris green	65	72	55	36	70	22	33	49	24	28	34	31	13	12	29	11	584
Pyrethrum and hellebore powders	34	38	33	39	52	51	45	77	43	17	60	92	72	42	29	58	782
Miscellaneous	155	161	193	248	255	84	42	74	40	51	92	55	61	56	58	74	1,699
Total	650	997	995	1,117	1,487	984	748	904	717	820	957	1236	824	864	992	950	15,242

IMPORT SAMPLES

During the period July 1, 1912, to June 30, 1927, 2,296 official and unofficial samples of insecticides and fungicides were collected through the various port stations of the Bureau of Chemistry for examination and test by the board. Disposition was made of 2,208 samples. Two hundred and twenty official samples were found adulterated or misbranded and it was recommended that the shipments be refused entry until correctly labeled. The remaining samples were unofficial, 360 of them being found to be adulterated or misbranded, or both, and in these cases it was recommended that future shipments be detained, while 1,610 were neither adulterated nor misbranded. Eighteen of the official samples were found to be neither adulterated nor misbranded. On June 30, 1927, samples from 88 shipments were undergoing analysis and test.

SUMMARY FOR 1927

During the year the board's attention has been largely engaged in collecting and examining new insecticides and fungicides. Some of these represent new manufacturers of the recognized standard remedies, but there is always a certain percentage of new theories of treatment represented by these new articles. It was found that many of the samples did not bear the active and inert ingredient statement required by section 8 of the act and a considerable number bore false and misleading claims relative to the insects and fungi they would control.

During the year the board has continued the campaign against preparations which are represented to be effective against chicken lice, chicken mites, blue bugs, and other external parasites infesting chickens, when fed in the food and drinking water. Our inspectors have kept under close observation the former manufacturers of these preparations. The principal method used by manufacturers to sell these fraudulent preparations is through the medium of inserting advertisements in farm papers. An examination of the various farm publications reveals that practically none

of them are now carrying the advertisements.

The campaign begun last year against a number of preparations for use to combat flies infesting animals was continued, and at the present time it appears that these products have disappeared from the market. The remedies consist essentially of mixtures of salt, sulphur, and either lime or charcoal. They are recommended for internal administration to the animals.

The campaign which has been under way for a number of years involving the inspection of shipments of calcium arsenate to be used for cotton-boll weevil control has been continued. The samples examined disclose that for the most part the calcium arsenate now being manufactured is of excellent quality.

A very encouraging tendency on the part of some of the most progressive manufacturers to carefully test their new preparations before placing them on the market has been noted during the last year. When such experiments are made by competent entomologists and thoroughly and conscientiously carried on they are very valuable and serve to protect the manufacturer as well as the consuming public. This work should, however, be attempted only by one who has a broad general knowledge of entomology and the principles involved in testing insecticides, since tests made by the layman are not only unreliable but frequently very misleading.

During the year the board reported to the solicitor of the department 47 cases presenting alleged violations of the law, with recommendations that the facts be transmitted to the Attorney General to institute criminal action or seizure proceedings. Disposition was made of 247 cases by correspondence with the manufacturers. On June 30, 1927, 89 cases were pending preliminary hearings or before the board for final action; 265 were held in temporary abeyance, pending the receipt of further information or the outcome of prosecution based on the same product or correspondence with the manufacturers; and 681 samples were undergoing analysis and test.

The inspectors and sample collectors of the board, operating throughout the United States, collected samples from 950 shipments.

During the year 358 official and unofficial import samples of insecticides and fungicides were collected through the various port stations of the Bureau of Chemistry for examination and test by the board. Disposition was made of 393 samples. Thirty official samples were found adulterated and misbranded, and it was recommended that the shipments be refused entry until correctly labeled. Three official samples were found to be neither adulterated nor misbranded and the shipments were released. The remaining samples were unofficial, 33 of them being found to be adulterated or misbranded, or both, and in these cases it was recommended that future shipments be detained, while 327 were neither adulterated nor misbranded.

SPECIAL INVESTIGATIONS

Various scientific investigations have been made by the board during the year in cooperation with the various bureaus of the department to obtain basic facts to aid in the enforcement of the law.

The extended investigation of the chemical nature of calcium arsenate which was undertaken several years ago in order to better understand the composition of this complex insecticide has been finished and will be presented for publication in the near future under the general head, "The preparation and properties of the arsenates of calcium." The results of the work are being prepared in the form of four papers entitled: "1. Compounds with CaO/As_2O_5 ratio 1"; "2. Compounds with CaO/As_2O_5 ratio 2"; "3. Compounds with CaO/As_2O_5 ratio 3"; and 4. Basic arsenates." Twelve distinct compounds, some new and others more thoroughly investigated than before, will be described in these publications.

Methods for the rapid detection and estimation of spray material remaining on vegetation after spraying have been studied with the view to furnishing a simple means of checking claims concerning adhesiveness and lasting qualities of spray material. A satisfactory method for sulphur residues on materials which have been dusted or sprayed with sulphur containing preparations was developed and is being used by the inspectors of the Office of Blister Rust Control of the Bureau of Plant Industry to determine whether bushes have been dipped in lime-sulphur solution as required by law. This work has been described in a paper entitled "A colorimetric method for the estimation of sulphur residues of sprayed foilage" which is soon to be presented for publication in the Journal of Agricultural Research. Attempts were made to develop a simi-

lar method for calcium arsenate. Some progress has been made and the study is being continued.

A study of methods for estimating particle sizes in dusting materials was made with the view to determining whether the degree of fineness influences the toxicity. Tests were run with lead arsenate, Paris green, and copper carbonate. Sifting of such materials with the aid of some liquid (alcohol was very suitable) gave good results down to a particle size equivalent to a 325-mesh screen, but since most insecticidal dusts average much finer than that, satisfactory grading is not obtained in that way. Various methods of sedimentation in liquids were tried. These required extreme care to give accurate results and so far no fairly simple and satisfactory method has been found. It is planned to continue this work.

Recently many publications in regard to the fluorides and fluosilicates have appeared in the entomological literature and as a result many products containing them, both alone and in mixtures, have appeared on the market. Since the methods by which they are detected and determined quantitatively are difficult at best and, in the case of many mixtures, have not been worked out at all, considerable study of such methods has been required. This study is being continued.

An investigation has been under way for some time of the loss of nicotine from soaps containing it. Such soaps have sometimes shown a very great decrease in percentage of nicotine over a comparatively short period. At other times the loss has been much slower, in fact so slow that it could hardly be detected in a year or more. In this investigation an attempt was made to show the effect both of the composition of the soap, including water content, free alkali or fat, etc., and method of packing on the decrease in percentage of nicotine. The nicotine was shown to decrease, not by volatilization but by change, probably by polymerization with the fatty material, to a resinous material. This work has been practically completed and will be prepared for publication in the near future. The results will indicate how soaps containing nicotine may be prepared and packed to prevent decrease in percentage in nicotine during storage.

The chemical investigation of the active constitutents of stavesacre seeds (*Delphinium staphasagria*) has been completed. The oil and alkaloid were separated and purified and their properties determined. The results of this work are described in a paper which will appear in an early number of the Journal of the American Pharmaceutical Association. The oil and alkaloid are being tested by the entomologists of the board to determine their insecticidal value.

An investigation has been made of methods of sulphonation of lubricating oils used as insecticides. This method is important because it is an index to the foliage injury which may be expected from the spray. A method has been suggested which gives satisfactory results and it has been presented to the Association of Official Agricultural Chemists for adoption as an official method. Investigations were also made as to the effects of various conditions (temperature, strength of acid, etc.) on the sulphonation, and these results have been published in a paper entitled "A study of methods proposed for the determination of the unsulphonated residue in petroleum spray oils" in the Journal of the Association of Official Agricultural Chemists.

An investigation has been undertaken to determine the relative effectiveness as insecticides of insect powders prepared from various types of pyrethrum flowers. Large samples of pyrethrum flowers from different sources were obtained from various jobbers. The flowers were carefully pulverized, portions were diluted with inert materials, and tests by the entomologists of the board are in progress. Other powders were extracted with mineral oil and various strengths of the extract were prepared for toxicity tests against insects. It is hoped to develop methods of testing that will show the relative efficiency of these preparations which are now being placed on the market in large numbers. In order to determine what part or parts of the individual flowers contained the highest concentration of the active principle, portions of open and half-closed flowers were carefully separated into their constitutent parts—ray flowers, disk flowers, achenes, etc.—and these individual parts ground and tested in the same manner as the complete flowers. The testing of these materials has been under way for the last six months and is not yet completed.

Pyrethrum powders on the market have been found to be adulterated with tumeric. A chemical method which was satisfactory for the detection of this material was worked out and the

quantitative application studied. This method has been of service in combating such adulteration.

Owing to the high price of cresol, U. S. P., a considerable number of manufacturers started to market, label, and sell a product under the designation of "Liquor Cresolis Compositus" or "Compound Solution of Cresol" which contained higher-boiling tar acids in place of cresol, U.S.P. The method given in the United States Pharmacopœia for testing the cresol in liquor cresolis compositus was found to be unsatisfactory, and a new method of testing it has been worked out which has proved to be effective in detecting such adulteration. In addition, considerable bacteriological work has been done on materials in which tar acids of known boiling point have been substituted for cresol. Manufacturers were informed that a product labeled "Liquor Cresolis Compositus" and containing other coal-tar acids than cresol was held to be misbranded and adulterated. As a result of this notice and of the other activities of the board, there has been a very considerable decrease in the marketing of goods of this type.

Study of the several methods of determining the phenol coefficient of water-soluble disinfectants was continued last year, special attention being given to a comparison of these methods and to devising a method which would be more satisfactory and convenient. Such a test was proposed and placed before the laboratory section of the American Public Health Association for adoption. Attention has also been given to the substances to which the ordinary methods are not applicable, disinfectants of a semisolid nature, those not miscible with water, volatile compounds, etc. An effort has been made to develop the "filter paper test" into a standard method for these substances.

In cooperation with the Bureau of Chemistry extensive investigations were made in the field of antiseptics whose wide range of uses renders the standard methods for disinfectants inapplicable in many cases. New and practical tests for determining the germicidal efficiency of these substances have been devised and the study is being continued.

A rapid method for the determination of petroleumlike hydrocarbons in oil sprays and animal dips was evolved during the year and the results published in Industrial and Engineering Chemistry, January, 1927, in a paper entitled, "Diethyl sulphate in the examination of hydrocarbon oils."

In view of the increased amounts of high-boiling phenols appearing on the market and finding their way into commercial disinfectants, and because of their difficulty of determination in coal-tar creosote disinfectants, a study was made to ascertain whether such phenolic bodies could be determined in a somewhat similar manner to that used for their determination in so-called "saponified cresol solutions." Accordingly, laboratory tests were made and a paper has been submitted for publication, containing the results of experimental work along this line. This work is being amplified to embrace the examination by this method of coal-tar creosote disinfectants, containing soaps made from various saponifying acids and oils.

Work was begun on the very broad subject of classifying, arranging, and comparing the chemical classes of disinfectants and antiseptics with respect to their value in the various fields of application. Samples representing the inorganic acids, alkalies, and salts, and the organic materials, such as alcohols, silver proteinates, coal-tar compounds, lysols, phenols, dyes, and essential oils were used. These samples were tested against various pathogenic organisms, in various media, and under varying conditions. This work has been undertaken in the hope that it will lead to a more thorough understanding of selective and specific action of substances so that proper and comprehensive tests may be devised to evaluate the evidently different types of disinfectants.

In cooperation with the Bureau of Entomology a large number of tests have been made with various arsenicals and other materials that might serve as stomach poisons for use against leaf-eating insects. This work was done in connection with the Bureau of Entomology's attempt to find a satisfactory substitute for arsenate of lead.

The field experiments with proprietary remedies for the control of the cotton-boll weevil have been continued and most of the labels for such remedies have been so corrected that they no longer contain any false or misleading claims. The few products that are still considered to be of doubtful value are being extensively tested in the field.

The question of moth repellents has been carefully studied and extensive tests with the two widely used materials, naphthalene and paradichloro-

benzene, indicate that while these materials are effective as fumigants, they can not in the true sense of the word be classed as repellents. This would mean that while naphthalene and paradichlorobenzene will be effective against moths when used in sufficient amounts in small, tight containers, the mere presence of the gases that they give off can not be relied on to prevent an infestation of moths.

In cooperation with the chemists of the board a study has been made of the insecticidal value of the alkaloids and oils found in larkspur seeds. This work is practically completed and it is hoped to have it ready for publication in the near future.

The uses and limitations of the more important types of fungicides now on the market have been further investigated by the plant pathologists of the board. New types of fungicides and new combinations, especially with insecticides, have been tested not only for their efficacy in the control of fungi but to determine their effects on the host plants. This work is planned and directed particularly with the view to obtaning information for the use of the board in criticizing or suggesting a revision of labels.

U. S. GOVERNMENT PRINTING OFFICE: 1927

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REPORT OF THE LIBRARIAN

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE LIBRARIAN,
Washington, D. C., August 31, 1927.

SIR: I have the honor to submit herewith the report of the library for the fiscal year ended June 30, 1927.

CLARIBEL R. BARNETT,
Librarian.

HON. W. M. JARDINE,
Secretary of Agriculture.

USE OF THE LIBRARY

The use of the library falls under two main heads, (1) the circulation of books and periodicals to readers in response to specific requests, and (2) the reference service, which includes the aid rendered in the use of books, the answering of specific questions, and the search for material relating to a certain subject.

CIRCULATION

Detailed combined statistics of circulation in the main library and the bureau libraries, in so far as such statistics are available, are given in Appendix 1. The total number of books recorded as circulated was 54,074. No records of the reference use are kept either in the main library or the bureau libraries. The circulation of current periodicals also can not be given as it is impracticable for the main library and several of the bureau libraries to keep detailed records of this circulation. From the figures in hand, however, it is estimated that the total circulation of current periodicals is over 300,000.

INTERLIBRARY LOANS

The use of the library is not limited to the department. Many books are lent to other Government offices and to libraries and scientific workers outside of the department. Among the Government and outside agencies in Washington which make frequent use of the library, particular mention should be made of the Tariff Commission, the Bureau of Labor Statistics, the Department of Commerce, the Federal Trade Commission, the Federal Farm Loan Bureau, the Reclamation Service, the Hygienic Laboratory, the Smithsonian Institution, the United States National Museum, and the Brookings Graduate School.

The distribution of loans outside of Washington is shown by States as follows:

Alabama	11
Arizona	20
Arkansas	47
California	53
Colorado	39
Connecticut	24
Delaware	75
Florida	134
Georgia	43
Idaho	24
Illinois	69
Indiana	38
Iowa	38
Kansas	30
Kentucky	24
Louisiana	13
Maine	3
Maryland	85
Massachusetts	67
Michigan	30
Minnesota	62
Mississippi	18
Missouri	32
Montana	37
Nebraska	33
New Hampshire	21
New Jersey	68
New Mexico	8
New York	188
North Carolina	64
North Dakota	5
Ohio	187
Oklahoma	40
Oregon	35
Pennsylvania	79
Rhode Island	4
South Carolina	26
Tennessee	3
South Dakota	1
Texas	17
Utah	47
Vermont	43
Virginia	109
Washington	30
West Virginia	15
Wisconsin	55
Wyoming	5
Alaska	1
Cuba	3
Porto Rico	13
Canada	40
Philippine Islands	1
Czechoslovakia	1
Total	2,158

The distribution of loans outside of the city by institutions was as follows:

Land-grant colleges and State experiment stations	1,195
Department of Agriculture workers stationed outside of Washington	461
Colleges and universities other than land-grant	112
Other scientific institutions	220
Business firms	82
Public libraries and miscellaneous	88
Total	2,158

In addition to the 2,158 books, 113 photostat copies and 33 typed copies of articles were supplied, making a total of 2,304 loans for the year, an increase of 285 as compared with the year 1926.

To meet requests for books not contained in this library, extensive use was made of the resources of other libraries both in and out of Washington. Grateful acknowledgment is made to the libraries which have given the department assistance in this way. The exact number of books borrowed from other libraries in Washington during the past year is shown in the following list:

Bureau of Education	11
Bureau of Ethnology	1
Bureau of Fisheries	9
Bureau of Mines	2
Bureau of Standards	26
Carnegie Endowment	2
Department of Commerce	1
Department of Justice	2
Fixed Nitrogen Research Laboratory	2
Geological Survey	61
Geophysical Laboratory	1
Hygienic Laboratory	6
Library of Congress	3,518
National Museum and Smithsonian Institution	61
National Research Council	5
Naval Observatory	1
Pan American Union	2
Patent Office	37
Public Health Service	16
Public Library	25
Surgeon General's Office	465
Weather Bureau	55
Total	4,309

In addition to the books borrowed from libraries in Washington, 75 books were borrowed from 35 different libraries outside of the city, as follows:

American Museum of Natural History	2
Arnold Arboretum	4
Boston Medical Library	1
Columbia University	2
Cornell University	5
Du Pont de Nemours Laboratory	1
Facts About Sugar, New York	1
Farlow Reference Library, Cambridge, Mass.	1
Iowa State College	2
John Crerar Library	5
Johns Hopkins University	5
Lloyd Library	6
Massachusetts State Library	1
Medical and Chirurgical Faculty, Baltimore	2
Museum of Comparative Zoology, Cambridge, Mass.	2
Maryland Historical Society	1
Missouri Botanical Garden	1
Notre Dame University	1
New York State Veterinary College	1
New York Academy of Medicine	1
Ohio State University	1
Purdue University	1
University of Chicago	6
University of Illinois	2
University of Maryland	1
University of Rochester	1
University of Minnesota	3
University of Pennsylvania	1
University of Wisconsin	5
Virginia State Library	1
Wistar Institute	1
Yale University	1
Dairy and Cold Storage Commission, Ottawa, Canada	3
Staats- und Universitätsbibliothek, Hamburg, Germany	1
A. Papineau-Couture, Montreal, Canada	2
Total	75

REFERENCE WORK

No list of reference questions asked of the library has been kept systematically either at the main library or in the bureau libraries but the following may be regarded as typical: Find patent for sewed pigskin container for meat products granted to J. H. Berg; find an account of Fayol and Fayolism (thought to be something like Taylorism); suggest sources for obtaining information about economic and social conditions of agriculturists in the United States in the eighteenth century, also in France; how can one find a list of colleges that give courses in advertising; can you dig up an account of a herd of "long-horn cattle" kept by an English nobleman; was Boonesboro, Md., formerly noted for its cantaloupes; meaning of term "Foxanian" as applied to maize in London seed, grain, and oil reporter; are there any data in regard to the number of farmers necessary to support a given city population; when was the F. A. Q. standard of wheat established in Australia; what foreign countries have crop insurance; what is the Patterson scheme of Government control of butter in Australia; what are the indications in the United States which show that the tendency of manufacturing industries is to locate near the sources of raw materials needed; what States published apple surveys in recent years; what are the rice harvesting dates for the world; what agricultural surveys have been made of countries bordering on the North Sea; what is the average size of farms in the United States, Germany, France, Denmark, Holland, and Poland; names and addresses of firms engaged in the manufacture of glue from milk, and information as to the extent of the industry; history of the development of the refrigerator car.

Reference work of a less interesting character but requiring in no less degree bibliographical knowledge and

familiarity with the literature of the subject concerned is the work of verifying incomplete and inaccurate references. During the past year the library of the Bureau of Entomology spent much time in assisting a scientific worker from another department in the verification of several hundred references to old scientific works needed in connection with the publication of a technical bulletin.

ACCESSIONS

The number of books, pamphlets, and maps added to the library during the year by gift, purchase and exchange was 14,168, a decrease of 1,047 over last year. The detailed figures follow:

Purchases:		
Volumes	2,207	
Pamphlets	90	
Maps	7	
Serials and continuations	643	
Total		2,947
Gifts:		
Volumes	1,018	
Pamphlets	1,020	
Maps	45	
Serials and continuations	5,408	
Total		7,491
From binding periodicals and serials		3,473
New current periodicals		257
Total accessions		14,168

In connection with the gifts, special mention should be made of a collection of 30 volumes of the botanical works of Alphonso Wood which were received from W. W. Eggleston of the Bureau of Plant Industry.

The number of books received from the Library of Congress by copyright transfer was 153.

The amount of money spent for books, periodicals, serials, and maps is given in Appendix 2, page 10.

Among the more important and valuable old books acquired were the following:

Baumann, C. A. Les camellias de Bollwiller. 1829–35.
Bellers, John. Proposals for raising a college of industry of all useful trades and husbandry. 1696.
Brossard, David. L'art et maniere de semer. 1543.
Coler, Johann. Oeconomia ruralis et domestica. 1680.
Coquebert de Montbret, A. J. Illustratio iconographia insectorum. 1799–1804.
Fitzgerald, R. D. Australian orchids. v. 2. 1884–94.
Geoponika. Der veldtbaw. 1545.
Geoponika. Der veldtbaw. 1554.
Gray, J. E. Spicilegia zoologica. pt. 1–3. 1828–1924.
Gurlt, E. F. Lehrbuch der pathologischen anatomie der haus-saugethiere. 1831–32.
L'Admiral, Jacob. Naauwkeurige waarneemingen omtrent de veranderingen van veele insekten. 1774.
Liboschitz, Joseph. Flore des environs de St. Petersbourg de Moscou. 1818.
Mattioli, P. A. New kreuterbuch. 1563.
Petagna, Vicenzo. Institutiones entomologicae. 1792.
Peters, W. K. H. Naturwissenschaftliche reise nach Mossambique ... 1842 bis 1848 ... Zoologie. V. Insecten und myriopoden. 1862.
Sahlberg, C. R. Insecta Fennica. 1834–[39?]
Schwander, J. G. Der sorgfältige haussshalter. 1674.
Scriptores rei rusticae. Libri de re rustica. 1533.

Further progress was made during the year in the completion of the files of periodicals. Following is a list of the most important sets completed or nearly completed:

Archiv für hygiene.
Besoeki, Java. Proefstation. Mededeelingen.
Deutsche forst-zeitung.
Missouri state horticutural society. Proceedings.
Münchener tierärztliche wochenschrift.
Paris. Institut national agronomique. Annales.

CATALOGUING AND CLASSIFICATION

The record of the material classified and catalogued during the year was as follows:

Volumes	3,225
Pamphlets	1,110
Maps and charts	52
Continuations and serials	6,051
Volumes received from bindery	2,252
Volumes in binders	1,221
New current periodicals	257
Total	14,168

In addition to the material which was fully catalogued, author cards only were made for 2,600 "reprints" and 170 pamphlets.

The amount of uncatalogued material on hand on July 1, 1927, was as follows: Volumes, 1,002; pamphlets, 2,326; continuations, 284; maps, 17.

The number of titles prepared for printing by the Library of Congress in the "Agr." series and the number of titles received is shown below:

	Prepared	Printed
Accessions and recatalogued books	606	887
Department publications	417	411
Agricultural periodicals	82	88
Total	1,105	[1] 1,386

[1] Includes some cards prepared in fiscal year 1926.

The number of manuscript cards waiting to be sent to the Library of Congress on July 1, 1927, was 866.

The number of cards added to the catalogue was 22,478. The cards withdrawn numbered 2,065, making a net addition of 20,413.

The total amount of cataloguing done during the year was slightly less than in the previous year, owing to the fact that two of the cataloguers worked

for several weeks on the soil bibliographies prepared by the library.

In addition to the catalogues maintained by the main library, which include records of all the books belonging to the department, there are a number of extensive special-subject catalogues and indexes maintained by the various bureaus covering the special subjects in which they are particularly interested. The number of cards added during the year to these special catalogues and indexes was approximately 44,000.

PERIODICALS

The record of current periodicals received by purchase, gift, and exchange was as follows:

Number of different periodicals received by purchase	1,132
Number of different periodicals received by gift and exchange	2,316
Total number of different periodicals received	3,448
Number of additional copies purchased	235
Number of additional copies received by gift and exchange	186
Total number of periodicals purchased, including duplicates	1,367
Total number of periodicals received by gift and exchange, including duplicates	3,869

The number of annual reports, transactions, proceedings, and other serials of infrequent issue received in the past year in addition to the current periodicals was over 6,000.

The work of recording our periodical holdings for the "Union List of Serials" now being compiled under the direction of a committee of the American Library Association continued to require much time throughout the year.

During the year the Bureau of Agricultural Economics library completed the work of consolidating the periodical and newspaper files of the three libraries which were united in 1922 to form the Bureau of Agricultural Economics library, namely, the library of the Office of Farm Management, the library of the Bureau of Crop Estimates, and the library of the Bureau of Markets. The consolidation of these files, which are now in good shape, has greatly facilitated the use of them. The consolidation could not have been effected without the additional space assigned to the Bureau of Agricultural Economics library during the past year.

BINDING

The number of books and periodicals sent to the Government Printing Office for binding was 3,108, practically the same number that were bound last year. In addition to the books and periodicals permanently bound, 2,608 were laced in temporary binders and 1,484 current numbers of serials were added to files already in binders. The number of pamphlets stapled in binders was 999. The cost of binding is given in the financial statement, Appendix 2, on page 11.

DUPLICATES

The sorting and disposition of duplicates required much time during the year. These duplicates are for the most part Government, State, and society publications which were sent to various offices of the department and later transferred to the library. Several lists were prepared and sent to libraries and book dealers. The numbers selected by book dealers realized an exchange value of $653.68.

In the Office of Experiement Stations library, 52 mail sacks of duplicate station publications were returned to the experiment stations during the past year.

EXCHANGES

During the year 1,801 orders were issued on the Office of Publications for the mailing of department publications which were requested by foreign institutions and officials and by societies and private individuals from whom publications are received in exchange. This was an increase of 316 orders over the previous year.

BIBLIOGRAPHICAL WORK

Three additions, Nos. 12–14, were made to the mimeographed series of bibliographical contributions of the library. No. 12, entitled "Peat: A contribution toward a bibliography of the American literature through 1925," was compiled by Alice C. Atwood, bibliographical assistant, Bureau of Plant Industry, at the request of the American Peat Society. No. 13, "A Classified List of the Soil Publications of the United States and Canada," was a joint production of several members of the staff of the main library and the bureau libraries, but the bulk of the work was done by Miss Marjorie F. Warner, bibliographical assistant, Bureau of Plant Industry. The compilation of this number and of No. 14, entitled "List of the Publications on Soils Issued by the United States Department of Agriculture, 1844–1926," by Emma B. Hawks, associate librarian, and Charlotte Trolinger, cataloguer, was undertaken by the library of the department at the request of members of the American organizing committee of the First International Congress of Soil Science, held in Wash-

ington June 13-22, 1927. A "List of Publications on Soils Issued by the State Agricultural Experiment Stations of the United States through 1926" is nearly complete and will be issued as Bibliographical Contribution No. 15.

Among the briefer bibliographies prepared in the main library was one of 12 pages entitled "Cotton: Brief List of Publications in English," compiled by Emma B. Hawks, associate librarian, and issued in July, 1926, as a supplement to Agricultural Library Notes for June, 1926.

In the Bureau of Agricultural Economics library the following additions were made to the mimeographed series of "Agricultural economics bibliographies":

No. 17. Farm Youth: A selected list of references to literature issued since January, 1920. Compiled by Margaret T. Olcott and Louise O. Bercaw. 40 p.

No. 18. Price fixing by Governments, 424 B. C.-1926 A. D. A selected bibliography, including some references on the principles of price fixing and on price fixing by private organizations. Compiled by Mary G. Lacy, Annie M. Hannay, and Emily L. Day. 147 p.

No. 19. The apple industry in the United States. A selected list of references on the economic aspects of the industry, together with some references on varieties. Compiled by Louise O. Bercaw. 168 p.

Four other mimeographed lists prepared by the Bureau of Agricultural Economics library, which were not included in the series noted above, were the following:

Idaho. A preliminary list of the sources of agricultural statistics. Compiled by Margaret T. Olcott. 14 p.

Some references on agricultural relief. 6 p.

Some references on agricultural relief. Supplement to a list issued November 17, 1926. 3 p.

Agricultural relief. Bills introduced in the Sixty-ninth Congress. 22 p.

Thirty-eight reference lists were prepared and are available in typewritten form. Among the more important of these are the following:

Some cost of production studies issued by the United States Department of Agriculture, including some studies issued by the States in cooperation with the United States Department of Agriculture. 13 p.

Taxation. List of references on taxation, with special reference to the farm. Compiled by Margaret T. Olcott and Emily L. Day. 18 p. (Supersedes two earlier lists.)

Some sources of California apple statistics. 10 p.

Legislation relating to agriculture recommended by certain organizations since 1921. With a list of acts passed by the United States Congress which seem to meet these recommendations. Compiled by Emily L. Day. 19 p.

Beginning with January, 1927, the Library Supplement to the BAE News which has been issued since January, 1923, changed its name to Agricultural Economics Literature. It was also somewhat enlarged in scope by the addition of several regular features. In addition to the signed reviews and the descriptive notes and abstracts of new material which have been appearing currently in the Library Supplement, Agricultural Economics Literature now carries each month (1) a list of State bulletins recently received with notes of contents, (2) a list of the publications of the United States Department of Agriculture, economic in character, (3) an annotated list of the outstanding periodical articles of the previous month, and (4) an annotated list of articles in foreign periodicals.

In the Bureau of Animal Industry library the work on the Index of Veterinary Literature has been greatly hindered on account of the fact that no typist has been available for the copying of the cards.

In the Bureau of Dairy Industry library the following lists of references were compiled and are available in typewritten form:

Flavors in milk as influenced by nutrition and physiology.

Mold in butter.

Comparison of raw and pasteurized milk.

The mimeographed list of periodicals of the United States relating to dairying was revised, and the mimeographed list of available department publications relating to dairying was revised three times. At the request of the National Association of Ice Cream Manufacturers, a comprehensive bibliography on ice cream is being prepared.

In the Bureau of Entomology library the index to American Economic Entomology is still in progress. A bibliography on "Weather conditions and the codling moth" was compiled by the assistant librarian, Miss Ina Hawes, and issued in mimeographed form. In addition, a number of brief lists were prepared, among them the following: Sodium arsenite; sheep tick; selected list of general entomological journals in English, French, German and Spanish, with prices and addresses of editors; dealers in natural history specimens and supplies; suggestions for a bibliography on metabolism of insects as affected by food supply and expressed by external characters; and popular entomology (revised).

The third biennial supplement to Department Bulletin 1199, List of Bulletins of the Agricultural Experiment Stations for the calendar years 1925 and 1926, prepared in the library of the Office of Experiment Stations, is ready to be submitted to the editor of the office, and it is hoped that it may be published before the end of this calendar year. The cataloguing of the ex-

tension publications received prior to 1916 has been finished for the States Alabama to Maine, inclusive.

In the Forest Service library brief bibliographical lists were prepared on the following subjects: Black locust; cork and cork oak; European larch; forest soils; hickory wood; logging methods; Norway spruce; phenological observations; timber of Washington State. The library continued to issue a monthly list of books and periodicals indexed, which was published in the Journal of Forestry.

In the Bureau of Home Economics library a bibliography entitled "Footwear" was compiled by the librarian and issued in mimeographed form as Home Economics Bibliography No. 1.

The Bureau of Plant Industry library continued to issue "Botany—Current Literature" and "Agronomy—Current Literature." The mailing list for the former now numbers 641 addresses and for the latter 245 addresses. Miss Alice C. Atwood, in addition to her bibliography on "Peat" which has been previously mentioned, prepared a list of publications on Rhododendrons and Azaleas which was published in the National Horticultural Magazine, April, 1927, pages 51–54. Miss Marjorie F. Warner, assistant librarian of the Bureau of Plant Industry, resumed work on her extensive bibliography of early horticultural works, which work had been interrupted by her absence from the department for three years.

The annotated list of periodical articles and new publications of interest in the work of the Bureau of Public Roads prepared in the library of the bureau and issued each week, was continued. The name of this mimeographed list was changed with volume 6, No. 16 (April 20, 1927), to "Highways and Agricultural Engineering." This now circulates to 122 members of the bureau staff in Washington and the various districts and to 109 other persons and organizations in the United States and foreign countries.

In addition to the more important bibliographies mentioned in the paragraphs above, many brief lists on various subjects were prepared in both the main library and the bureau libraries in response to requests from correspondents.

LEGISLATIVE WORK

During the sessions of Congress considerable time is required in keeping track of legislative matters bearing upon the work of the department, particularly in the Bureau of Agricultural Economics library and in the Bureau of Public Roads library. In these libraries the Congressional Record is read each day and items of interest to their bureaus are called to the attention of the heads of divisions and offices which are concerned. Records of the progress of bills and a file of the bills, reports, and hearings are also kept. Each week during the sessions of Congress an assistant from the Bureau of Agricultural Economics library examines the list of hearings received by the library of the Superintendent of Documents' office and hearings of interest to the work of the department are noted and requested from congressional committees. Many inquiries regarding the status of certain bills are received during the sessions and immediately after their close. Requests are also received for acts previously passed, such as the Webb-Pomerene Act, the Clayton Act, and the filled milk act. In some cases it is not easy to identify the act by the name given, as the name is usually that of the author or authors and may apply to more than one act. Some legislative reference questions received during the past year included an inquiry regarding the incorporated laws of 1923 governing producers' contracts; a request for information as to the purpose of the International Trade Exposition for which Congress had passed an appropriation; a request for the citation to the law under which the Bureau of Agricultural Economics issues grades for beef; an inquiry as to whether there is any law on the statute books showing the relation of the United States Department of Agriculture to the International Institute of Agriculture; and a request for the organic act creating the Consular Service in the State Department.

TRANSLATING

Better translating facilities is one of the outstanding needs of the department, especially for the less well-known languages such as the Slavic, Japanese, Chinese, and Scandinavian. At the present time only one or two bureaus have regular translators, although several of the bureaus employ clerks who are required to have a knowledge of foreign languages in connection with the work they are doing. When other bureaus need to have translating done they generally have it done outside of the department as special jobs or else have it done by translators in other Government departments in accordance with the procedure outlined in

Memorandum No. 18 of the Interdepartmental Board of Simplified Office Procedure relating to the translating of documents by Government employees. The present practice is, however, unsatisfactory in many respects and does not meet the needs of a research institution such as the department. It is hoped that a translators' "pool" of some sort may be established in the department in the near future. There are a number of reasons why it would be desirable to have the work done in the library and placed under the direction of the library. The library has much material in foreign languages which could be brought to the attention of investigators much more effectively if translations or abstracts could be furnished. It would also be most helpful to have translators convenient to the library for consultation in connection with the cataloguing and indexing of foreign publications and in connection with the reference work.

BUREAU AND DIVISION LIBRARIES

There have been no marked changes during the past year in the work of the bureau, division, and office libraries. A list of these branch libraries and various data in regard to them will be found on page 12, Appendix 3. The statistics of circulation are given in the table on page 9, Appendix 1. Their other activities, such as bibliographical work, cataloguing, reference work, etc., are described in the body of the report under various headings.

COOPERATION WITH OTHER LIBRARIES AND INSTITUTIONS

The past year has seen the actual beginning of definite cooperation with two States in the work of indexing the State agricultural statistics. In accordance with plans made by Miss Mary G. Lacy, librarian of the Bureau of Agricultural Economics, the Oklahoma Agricultural and Mechanical College sent the assistant librarian of the college in July, 1926, to work for two months in the Bureau of Agricultural Economics library on the index of the official agricultural statistics of Oklahoma, and the agricultural economics division of the College of Agriculture, University of California, gave a grant of $300 to employ an assistant to work in the Bureau of Agricultural Economics library on the California index. The Oklahoma index has been completed and the California index is well under way.

It has for many years been the policy of the library to give opportunities to librarians and assistants connected with the State agricultural colleges and experiment stations to have experience in this library. In the further extension of this general policy, an arrangement was made during the past year with the librarian of the International Institute of Agriculture at Rome, Italy, whereby an assistant from the institute library, Mlle. Aline Payen, spent six months working in this library in order to become familiar with the methods and resources of the library.

The mimeographed publication entitled "Agricultural Library Notes," which was begun in January, 1926, on the recommendation of the agricultural libraries section of the American Library Association, was continued throughout the past fiscal year and is proving a useful medium of communication between agricultural libraries.

At the request of the American organizing committee of the First International Congress of Soil Science, held in Washington June 13–22, the library prepared an exhibit of old and recent American soil literature as a part of the large exhibit which the committee held in connection with the congress. The collection of old books showed the development of American soil literature, beginning with Jared Eliot's Essays on Field Husbandry, issued in 1747, the first American book on agriculture. There were also copies of some of the earliest geological and agricultural surveys. Recent literature was represented by a collection of the soil publications of the department, and a collection of the recent standard American books on soils and fertilizers. Photographs of a number of pioneers in soil science in this country were also shown.

LIBRARY STAFF

The number of permanent employees carried on the staff of the main library at the close of the fiscal year was 33, a decrease of 1 as compared with 1926. The number permanently employed by the bureau and office libraries was 54. The total number permanently employed in the main library and the bureau and office libraries was 87, distributed as follows: 14 in administrative positions, including the librarian of the department, the heads of divisions in the main library, and the librarians of the bureaus; 39 assistant librarians, junior librarians, library assistants,

and junior library assistants; 11 under and minor library assistants; 14 clerical assistants; 1 translator; 5 messengers; and 3 charwomen. In the main library two assistants resigned to accept positions outside of the department and two were transferred to other bureaus of the department.

In the Bureau of Chemistry library Miss Minerva G. Beckwith was appointed librarian on August 16, 1926, to fill the vacancy caused by the death of Miss Louise Duval on August 8, 1926, after several months' illness.

The library again has the services of Miss Majorie F. Warner. She was appointed on October 1, 1926, as bibliographical assistant in the Bureau of Plant Industry library.

Staff meetings, including the staffs of both the main library and the bureau libraries, were held each month from October to June. At four of the meetings the staff had the privilege of hearing talks by outside speakers as follows: November, Julia Wright Merrill, executive assistant, committee on library extension, American Library Association, on the extension work of the American Library Association; December, A. F. Woods, director of scientific work, on the new buildings for the department; February, Neil E. Stevens, Bureau of Plant Industry, on Botanists as Human Beings; May, Louise Stanley, Chief, Bureau of Home Economics, on the work of the bureau. At the other meetings talks were given by members of the library staff. The meeting for March took the form of a debate on the question, "Resolved, That the book collections (aside from small reference collections) and the book circulation should be centralized in the main library when the bureaus are located in close proximity to the library."

The librarian of the department, the librarians of several of the bureaus, and various other members of the library staff attended the fiftieth anniversary meeting of the American Library Association at Atlantic City in October, 1926. The librarian of the Bureau of Agricultural Economics attended the meeting of the American Library Association in Toronto in June, 1927.

The librarian of the department served as chairman of the agricultural libraries section and as chairman of the Eunice Rockwood Oberly memorial fund of the American Library Association during the past year. The librarian of the Bureau of Agricultural Economics served as vice president and the librarian of the Bureau of Entomology as a member of the executive committee, of the District of Columbia Library Association.

LIBRARY FINANCES

The receipts and expenditures of the library for the past year are given in Appendix 2, pages 10–11.

An increase in the library appropriation for the fiscal year 1929 is urgently needed for books and periodicals, particularly for the purchase of old and rare books and for completing imperfect series. An increase also in the salary allotment is greatly needed for the employment of two additional cataloguers, as it is impossible with the present staff to keep the cataloguing up to date.

APPENDIX 1

Combined statistics of circulation

Bureau or office library	To individuals	To main library	To branch libraries	Total	Current periodicals
Main library	20,566	----------	26,636	47,202	(1)
Agricultural Economics	13,190	942	50	14,182	(2)
Animal Industry	2,131	208	106	2,445	30,661
Chemistry	7,248	1,048	35	8,331	32,541
Dairy Industry	2,273	63	----------	2,336	20,975
Entomology	3,585	528	16	4,129	5,143
Experiment Stations	(3)	(2)	(2)	(3)	(3)
Forest Service	1,848	462	5	2,315	9,177
Home Economics	(2)	(2)	(2)	3,880	7,565
Plant Industry	(4)	(4)	(4)	(4)	40,698
Public Roads	3,233	432	(2)	3,665	13,972

[1] No record of the circulation of periodicals is kept in the main library for the whole year, but it is kept for 1 month each year.

[2] Figures not available.

[3] No exact circulation figures are available for the Office of Experiment Stations. The circulation is, however, large, as the office, in connection with the work of the experiment stations, receives all new books and periodicals which are needed for review and abstracting; 950 periodicals are regularly circulated and many more specially requested. The circulation is estimated to be not less than 50,000.

[4] The Bureau of Plant Industry library does not maintain a collection of books, as it is in close proximity to the main library. The circulation of books to members of the bureau is, therefore, included with those for the main library but circulation figures are available for current periodicals, as this circulation is handled in the Bureau of Plant Industry library.

APPENDIX 2

Financial statement, fiscal years 1918 to 1927

RECEIPTS

	Fiscal year—									
	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Source:										
Library appropriation—										
Statutory salaries	$32,160.00	$32,160.00	$32,160.00	$32,880.00	$30,060.00	$32,660.00	$32,660.00	$40,000.00	$38,680.00	$54,680.00
General expenses	18,000.00	18,000.00	18,000.00	22,000.00	21,400.00	25,000.00	30,000.00	30,960.00	29,500.00	29,500.09
Total	50,160.00	50,160.00	50,160.00	54,880.00	51,460.00	57,660.00	62,660.00	70,960.00	68,180.00	84,180.00
From department printing and binding fund	12,068.38	5,358.21	9,210.70	7,031.20	14,549.59	7,460.64	10,621.26	13,171.04	9,983.30	13,173.75
Main library salaries paid by bureaus			1,467.50	5,221.67	7,560.02	10,472.89	12,257.50	15,117.84	16,521.50	
Grand total	62,228.38	55,518.21	60,838.20	67,132.87	73,569.61	75,593.53	85,538.76	99,248.88	94,684.80	97,353.75

EXPENDITURES

Books and serials	$7,257.40	$7,186.86	$9,246.05	$9,439.69	$9,998.58	$11,182.48	$11,138.26	$13,582.31	14,640.41	[1] 14,447.65
Periodicals	4,252.74	6,139.99	5,231.48	6,039.62	6,353.68	7,008.48	6,916.54	6,937.19	7,178.54	7,475.19
Maps	40.88	.70	62.04							
Index cards	78.86	85.25	112.23	178.51	141.88	172.45	147.37	162.45	169.30	137.88
Furniture, shelving, and miscellaneous equipment	765.88	604.04	293.16	2,525.94	29.91	2,435.20	1,738.15	1,908.83	404.77	476.86
Traveling expenses		179.44	48.52	219.72	190.23	177.52	971.06			78.44
Freight, express, and drayage	16.24	37.75	93.07	56.94	62.90	13.95	21.51	44.97	42.29	16.52
Supplies and repairs	981.33	609.01	539.58	518.50	566.76	1,459.67	1,136.98	1,015.01	971.84	[2] 1,111.79
Truck service					9.87	52.78	38.89	81.81	85.80	78.87
Newspapers						94.16	99.32	97.80	99.60	
Salaries (statutory)	31,523.92	29,401.95	29,106.85	27,013.25	30,059.01	32,219.04	31,960.67	39,799.96	38,613.92	54,066.54
Salaries (miscellaneous)	1,748.33	2,039.00	2,356.00	2,921.35	3,931.62	2,394.35	7,774.99	6,194.51	5,080.00	5,319.96
Total	46,665.58	46,283.99	47,088.98	48,913.52	51,344.44	57,210.08	61,943.74	69,824.84	67,286.47	83,209.70

Printing	1,576.78	652.75	348.56	342.34	1,826.01	579.03	567.97	444.47	477.32	327.96
Binding	10,491.60	4,705.46	8,862.14	6,688.86	12,723.58	6,881.61	10,053.29	12,726.57	9,505.98	12,845.79
Main library salaries paid by bureaus			1,467.50	5,221.67	7,560.02	10,472.89	12,257.50	15,117.84	16,521.50	
Grand total	58,733.96	51,642.20	57,767.18	61,166.39	73,454.05	75,143.61	84,822.50	98,113.72	93,791.27	96,383.45
Credit received for duplicates exchanged with book dealers and libraries							954.75	604.35	216.35	653.68
Gifts							12.94	10.75		

[1] Outstanding liabilities for books, periodicals, and serials, $331.84.

[2] Itemized as follows:

Cleaning and toilet supplies	$124.22
Stationery	247.40
Miscellaneous office supplies	289.02
Binding material	95.91
Total	756.55
Repairs and alterations:	
Carpentry work	57.49
Electrical work	60.04
Typewriter repairs	48.00
Painting	120.91
Miscellaneous repairs	68.80
Total	355.24

APPENDIX 3

Bureau libraries [1]

Bureau or office	Number employed	Number of books	Number of pamphlets	Number of periodicals currently received	Number of registered borrowers	Number of registered borrowers to whom periodicals are circulated
Agricultural Economics	[2] 15	[3] 25,000	([4])	1,686	386	[5] 134
Animal Industry	2			518	66	60
Animal Husbandry Division	1	[3] 2,800	([4])	([4])	([4])	([4])
Chemistry	[6] 4	9,717	([4])	477	288	130
Dairy Industry	4	615	[3] 4,700	371	69	58
Entomology	3	10,086	[3] 11,700	876	136	31
Experiment stations	8	3,958	([4])	720	78	
Forest Service	1	24,567	([4])	[3] 180	144	70
Home Economics	2	([4])	([4])	158	([4])	([4])
Plant Industry	11	[3] 600	[3] 1,100	900	([7])	183
Public Roads	3	6,520	10,997	318	149	96

[1] The Weather Bureau library is administered separately, with the exception that the books and periodicals are purchased from the appropriation for the library of the department, the sum of $1,000 being set aside each year for this purpose. The report of the Weather Bureau library is contained in the report of the Weather Bureau.
[2] Including messenger.
[3] Approximate figures.
[4] Figures not available.
[5] Offices.
[6] Including translator.
[7] Book circulation handled in main library.

U. S. GOVERNMENT PRINTING OFFICE: 1927

MAY 1 1928

REPORT OF THE CHIEF OF THE PACKERS AND STOCKYARDS ADMINISTRATION

United States Department of Agriculture,
Packers and Stockyards Administration,
Washington, D. C., August 25, 1927.

Sir: I have the honor to transmit herewith a report of the Packers and Stockyards Administration for the period from April 1, 1926, to June 30, 1927.

Respectfully,

John T. Caine, *Chief.*

Hon. W. M. Jardine,
Secretary of Agriculture.

This is the sixth annual report of the Packers and Stockyards Administration. The last published report covered the period from July 1, 1924, to March 30, 1926, and included considerable special information called for by Senate Resolution No. 145, dated February 16, 1926. The report herewith covers the activities of the administration not only for the fiscal year ended June 30, 1927, but also for the remainder of the previous fiscal year from April 1 to June 30, 1926. Effective July 1, 1927, the Packers and Stockyards Administration will be abolished as an independent unit and the administration and enforcement of the packers and stockyards act, 1921, placed under the direction of the Chief of the Bureau of Animal Industry. This, therefore, will be the last report of the administration as a separate organization and next year the report of this division will be incorporated with that of the Bureau of Animal Industry.

In general, there has been substantial progress in the enforcement of the packers and stockyards act during the fiscal year just closed. A number of important decisions were rendered, which are treated in detail elsewhere in this report. In addition, the extent and importance of informal actions have been notable and have contributed much toward the constructive correction of a variety of problems. The program of economy enjoined upon all Federal departments has been carefully observed, and it has been possible to prepare for the work of the ensuing fiscal year under reduced appropriations, but without loss of efficiency or detriment to the purposes sought to be accomplished.

There have been no essential changes in the organization at Washington since the issuance of the previous report. There are three main divisions of enforcement activity, namely, audits and accounts, rates and registrations, and trade practices. The field organization remains essentially as it was in the preceding year.

PERSONS SUBJECT TO THE ACT

Persons, firms, or corporations engaged in business as packers, stockyard owners or operators, market agencies or dealers, within the meaning of the definition given those terms by the law, are subject to the provisions of the packers and stockyards act. Of these classes market agencies and dealers are required to register with the Secretary, and stockyards must be posted by the Secretary to bring them within jurisdiction. The following list and Table 1 show details as to the number of persons subject to the provisions of the act, as of June 30, 1927. In the case of packers,

65705—27——1

where no registration or posting is required, a complete list is not available, since more or less continuous investigation is under way to determine whether numerous packers are subject to jurisdiction.

STOCKYARDS

The following is a list of 80 stockyards which are posted as being subject to the act, showing the stockyard owners, location, and date of posting:

Stockyard owner	Location	Date posted
Western Stock Yard Co	Amarillo, Tex	July 1, 1922
New Orleans Stock Yards, Inc	Arabi, La	Nov. 1, 1921
Atlanta Union Stock Yard, Inc	Atlanta, Ga	Do.
J. W. Patterson Commission Co	do	Apr. 1, 1922
J. K. Shippey & Bro	do	Apr. 30, 1924
Augusta Stock Yard Co	Augusta, Ga	Nov. 1, 1921
Union Stock Yard Co	Baltimore, Md	Do.
Union Stock Yards Co. of New Jersey	Benning, D. C	Do.
Brighton Stock Yards Co	Brighton, Mass	Do.
New York Central Railroad Co. (the Buffalo Stock Yards)	Buffalo, N. Y	Do.
Foust-Yarnell Stock Yards	Chattanooga, Tenn	Do.
Union Stock Yard & Transit Co. of Chicago	Chicago, Ill	Do.
Cincinnati Union Stock Yard Co	Cincinnati, Ohio	Do.
Cleveland Union Stock Yards Co	Cleveland, Ohio	Do.
Columbia Stock Yards Co	Columbia, S. C	Do.
Drovers Union Stock Yards	Columbus, Ohio	Do.
Dallas Union Stock Yards Co	Dallas, Tex	July 1, 1922
Union Stock Yards Co	Dayton, Ohio	Nov. 1, 1921
Denver Union Stock Yard Co	Denver, Colo	Do.
Michigan Central Railroad Co. (the Detroit Stock Yards)	Detroit, Mich	Do.
El Paso Union Stock Yards Co	El Paso, Tex	Do.
Independent Stock Yards Co	do	Do.
Evansville Union Stock Yard Co	Evansville, Ind	Do.
Fort Wayne Union Stock Yards Co	Fort Wayne, Ind	July 1, 1922
Fort Worth Stock Yards Co	Fort Worth, Tex	Nov. 1, 1921
Fostoria Union Stock Yards Co	Fostoria, Ohio	Do.
Galesburg Horse & Mule Co. (Inc.)	Galesburg, Ill	Apr. 16, 1925
Belt Railroad and Stock Yards Co	Indianapolis, Ind	Nov. 1, 1921
National Stock Yards	Jacksonville, Fla	Do.
The Jersey City Stock Yards Co	Jersey City, N. J	Do.
Kansas City Stock Yards Co	Kansas City, Mo	Do.
East Tennessee Stock Yards	Knoxville, Tenn	Do.
Lafayette Union Stock Yard Co	La Fayette, Ind	Do.
Union Stock Yard Co	Lancaster, Pa	Do.
W. E. Mayberry (Union Stock Yards)	Laredo, Tex	Dec. 1, 1922
Los Angeles Union Stock Yards Co	Los Angeles, Calif	Nov. 1, 1922
Bourbon Stock Yard Co	Louisville, Ky	Nov. 1, 1921
Marion Union Stock Yards Co	Marion, Ohio	Do.
Memphis Union Stock Yards	Memphis, Tenn	Do.
Darnell-Harris Commission Co. (Darnell Stockyards)	do	Apr. 1, 1924
Dixie-National Stock Yards	do	Nov. 1, 1921
South Memphis Stock Yards, Inc	do	Do.
Meridian Union Stockyards	Meridian, Miss	May 1, 1926
Milwaukee Stock Yards Co	Milwaukee, Wis	Nov. 1, 1921
Union Stock Yards Co. of Montgomery (Inc.)	Montgomery, Ala	Do.
Hall Commission Co., Lessee (Southern Stock Yards)	Moultrie, Ga	Do.
Farmers National Stockyards Co	Muncie, Ind	Mar. 5, 1924
Nashville Union Stock Yards (Inc.)	Nashville, Tenn	Nov. 1, 1921
St. Louis National Stock Yards	National Stock Yards, Ill	Do.
Newark Stock Yards	Newark, N. J	Do.
Union Stockyards & Market Co. (Inc.)	New York, N. Y	Do.
Portland Union Stock Yards Co	North Portland, Oreg	Do.
Salt Lake Union Stock Yards	North Salt Lake, Utah	Do.
Union Stock Yards	Ogden, Utah	Do.
Oklahoma National Stock Yards Co	Oklahoma City, Okla	Do.
Pasco Union Stock Yards Co	Pasco, Wash	Do.
Peoria Union Stock Yards Co. (Inc.)	Peoria, Ill	Do.
West Philadelphia Stock Yard Co	Philadelphia, Pa	Do.
Pittsburgh Union Stock Yards Co	Pittsburgh, Pa	Do.
Pueblo Stock Yards Co	Pueblo, Colo	Apr. 1, 1922
Richmond Union Stock Yards Co	Richmond, Va	Oct. 31, 1921
Southern Stock Yards Corp	do	Do.
Union Stock Yards, S. A	San Antonio, Tex	Nov. 1, 1921
Johnson & Moffat, Lessee (Union Stock Yards)	San Francisco, Calif	Dec. 3, 1923
Union Stock Yards Co	Seattle, Wash	Nov. 1, 1921
Sioux City Stock Yards Co	Sioux City, Iowa	Do.
Sioux Falls Stock Yards Co	Sioux Falls, S. Dak	Do.
Union Stockyards Co. of Omaha (Ltd.)	South Omaha, Nebr	Do.
South San Francisco Union Stockyards Co	South San Francisco, Calif.	May 3, 1927
St. Joseph Stock Yards Co	South St. Joseph, Mo	Nov. 1, 1921
St. Paul Union Stockyards Co	South St. Paul, Minn	Do.
Spokane Union Stock Yards Co	Spokane, Wash	Do.

Stockyard owner	Location	Date posted
Springfield Stockyards	Springfield, Ill	Feb. 11, 1926
Springfield Stockyards Co	Springfield, Mo	Dec. 3, 1925
Springfield Union Stock Yards Co	Springfield, Ohio	Nov. 1, 1921
Stockton Feed Yards	Stockton, Calif	Dec. 17, 1926
Inter-State Stock Yards Co	Toledo, Ohio	Nov. 1, 1921
Toledo Union Stock Yards Co	do	Do.
Patrick Horan & Sons (New York Central Stock Yards)	West Albany, N. Y	Do.
Wichita Union Stock Yards Co	Wichita, Kans	Do.

Since March 30, 1926, the following stockyards have been posted:
Meridian Union Stockyards, Meridian, Miss.
Stockton Feed Yards, Stockton, Calif.
South San Francisco Union Stockyards Co., South San Francisco, Calif.

TABLE 1.—*Number of commission men and other market agencies and dealers registered*

Class	Number of agencies handling—						Total
	All species	Cattle	Hogs	Sheep	Horses and mules	Other	
Market agencies:							
Commission men	757	10	3	12	16	8	806
Order buyers	140	80	27	10		20	277
Clearing agencies [1]							39
Miscellaneous [2]							194
Total market agencies	897	90	30	22	16	28	1,316
Dealers:							
Buyers	764	530	232	115		290	1,931
Traders	157	664	211	47		51	1,130
Buyers and traders	309	156	28	6		72	571
Miscellaneous	13	8					21
Total dealers	1,243	1,358	471	168		413	3,653
Total registrations	2,140	1,448	501	190	16	441	4,969

[1] Does not include commission men and order buyers who render clearing services.
[2] Does not include commission men and order buyers who render miscellaneous services.

REGISTRANTS

Table 1 gives an analysis of the registrants, showing the character of service rendered, and the classes of livestock handled by them at all the posted markets.

In each case a firm or corporation engaged either as a dealer or market agency is registered as such. Therefore, this list of registrants does not indicate the number of individuals actually engaged in the operations of buying or selling at the posted markets.

PACKERS

For the year 1925 reports were received from 615 packers. To June 30, 1927, reports had been received from 604 packers. A systematic effort is being made to develop a more complete list of the packers who are subject to the act.

TRADE PRACTICES

The Division of Trade Practices has to do with what may be termed the ethics of the business conduct of persons subject to the provisions of the act.

The supervisors informally settled many minor problems that arose on all markets. Among these may be listed such items as procuring bonds from registrants, quality of feed, obtaining information at request of consignors of livestock, conferring with stockyards companies on pen assignments and other stockyards services and facilities, complaints on trade practices, assisting in obtaining better prices for, and more expeditious handling of, crippled and dead livestock and reactor cattle, humane handling of livestock, and assistance in settling complaints in such matters as price, weight, and dockage.

Certain principles of importance to producers of livestock in connection with marketing have been considered and acted upon in several cases. There are outlined below the details as to some of the cases of more than ordinary interest. Considerable attention was also given to the practice generally known in the trade as "weighing-up." Studies of the cause and effect of the practice were made and in one proceeding this matter was one of the things included for consideration. The relation, either through financial interests or through common directorates or management, between selling and buying agencies at various markets has also been under careful consideration with a view to determining whether such relations tended to create, or had the effect of creating, any conditions disadvantageous to producers and shippers. This involved a study of the practices followed by agencies wherein such relations exist and also a study of the legal aspects of the situation. Additional time and study are necessary in order to determine upon a course of procedure which will meet the practical considerations and at the same time will afford proper safeguards.

On another market a practice existed whereby hogs were sold on a so-called "schedule" basis. That is, hogs averaging between certain weight limits would bring a given price. A difference of 20 pounds in weight was generally used for the different price classifications. Under such a method it was possible to cause an injustice to the consignor through failure to recognize variations in quality. Furthermore, the principle of competitive bidding was not being used, and a more or less tacit division of the receipts was made. A satisfactory informal settlement was accomplished, and the practice was abolished. Pen-to-pen selling was adopted wherein each lot of hogs is sold on its individual merits.

On the same market it was customary to begin trading operations in the truck-in division at 6.30 a. m., while in the car-lot division 8 a. m. was the usual hour. This resulted in confusion and in a considerable amount of unnecessary charges in selling, which eventually the consignor had to assume. In connection with this situation there also existed at this market unsatisfactory facilities for the handling of sheep and calves. Through the cooperation of the stockyards company a new truck-in hog division adjoining the car-load division is being erected. It is the intent that the two markets shall open at the same hour when the truck-in-hog division is completed. This instance serves as an illustration of what may be accomplished through informal methods.

On another market the principal buyer was engaging in a practice in the purchasing of hogs that resulted in confusion to the market agencies in accounting correctly to the shipper. He did not grade the hogs at the time of purchase. If the market agency had graded them in a manner it thought correct, and had remitted to the consignor, the buyer would frequently regrade them and make a settlement with the market agency different from that the market agency had made with the consignor. This matter was informally taken up with the head of the company for which this buyer made purchases, and he readily agreed to instruct the buyer to make his purchases in accordance with the usual and customary manner, and the matter appears to be satisfactorily adjusted.

On another market an order buyer took the position that certain market agencies were indebted to him for a large sum of money on account of what he alleged were the unauthorized acts of his employee. To reimburse himself he purchased livestock from these market agencies and withheld payment therefor in an amount equal to that which he claimed was due. The market agencies from whom the livestock was purchased incurred as a result a very large overdraft in the proceeds, due to consignors. Fortunately no loss occurred to any shipper, nor was it necessary to call upon the bonds. A hearing was held, a finding made, and the respondent ordered to cease and desist from engaging further in the practice. He was also suspended as a registrant and could not engage in business on any market under the supervision of the Secretary during the period of suspension. The important principle was established that market agencies may not cause livestock shippers to be deprived of their proceeds in order to collect alleged debts due from other market agencies.

A great deal of attention has been given to seeing that a fair price is obtained for dead animals and reactor cattle.

Investigations have also been carried on relative to the produce-buying

activities of packers. Several field investigations have been made, and in one instance a hearing was held to determine the facts. A satisfactory solution of some of the complaints was obtained for the complainants by investigating conditions and discussing them with those interested.

SCALES AND WEIGHING

The subject of frequent scale inspection has received special study. As a result, a scale-inspection outline and report has been prepared. This has been printed and put to use on livestock scales. The form outlines in a definite series of questions the features of livestock scales which should receive special attention.

It is found that persons not familiar with the inspection of scales can learn to use the reports and make the scale inspection and are able to recognize and correct defects that formerly would go unnoticed.

Demonstration tests, inspection of scales, observing and assisting in the use of testing equipment have taken a large part of the time of the livestock weight supervisors and have been essential features of the activities of the Packers and Stockyards Administration in the scales and weighing work.

There has been a continuous demand for information on scales from sources both in the livestock industry and outside. These have been complied with by furnishing copies of a large number of articles on features respecting scales and weighing which have been prepared at different times.

The desirability of introducing small scales for weighing small drafts and single animals and improving the arrangement of scales has been persistently urged. Improvements have been made at several yards. One of the stockyards installed a weighing unit directly in line with the suggestion of the administration, consisting of a large and a small scale side by side. From his weighing position the weigher commands a view of the scale platforms and approaches.

BONDS

The general rules and regulations for the enforcement of the packers and stockyards act, promulgated by the Secretary, were amended, effective September 1, 1923, so as to require the execution and maintenance of bonds by market agencies. This regulation was based upon the discretionary authority vested in the Secretary by the act and upon the general principle that persons handling funds in a fiduciary capacity, such as livestock commission men, should be required to guarantee the safety of such funds.

In the act making appropriation for the enforcement of the packers and stockyards act for the fiscal year 1925 it was provided in effect that the Secretary of Agriculture might require bonds from every market agency and dealer under such rules and regulations as he might prescribe to secure the performance of their obligations. Under this authority the Secretary promulgated regulations effective November 1, 1924, requiring bonds of market agencies and dealers who incurred financial obligations.

Some legal complications in connection with the interpretation of the law as respects packers and packer-buyers have resulted in considerable delay in procuring bonds from packers who buy livestock at public markets. Among other classes of registrants there has been a general compliance with the Secretary's bond regulations. As one bond may cover many registrants, as in the case of brokers or clearing agencies, and blanket bonds given by exchanges, a statement of the total number of bonds on file will not correspond to the total number of registrants. However, there were on July 1, 1927, approximately 1,400 surety bonds on file, of which 573 were submitted within the past year. Some of these new bonds were, of course, intended to supersede old ones which were canceled by the surety companies, but the large number of bonds submitted indicates the tendency upon the part of the trade to comply with existing regulations.

Certain classes of registrants who render stockyards services and must register as agencies have no financial obligations under the Secretary's regulations and are exempt from giving bond. Practically all commission men who act in a fiduciary capacity for shippers of livestock have given some form of surety bond.

The administration in the enforcement of the bonding regulations has followed the policy of informal procedure in most cases. In some instances during the past year formal proceedings were instituted against several registrants for violations of the bond regulations. Such proceedings resulted in a satisfactory bond being given in all cases where the registrant continued to operate at a public stockyard.

BACON PACKAGES

The attention of the administration was directed to the practice of packing dried beef and sliced bacon in so-called odd-ounce packages. It was stated that the custom of the meat trade for years had been to pack these products in cartons or wrappers containing even multiples of a pound, as 4 and 8 ounces, or in full-pound sizes. Contention was made that departure from this established custom was not justified by consumer demand or by reasons of economy in manufacture and distribution. Further, it was alleged that the consumer was, or could readily be, deceived inasmuch as the packages which contained 7 ounces or other odd amounts simulated in appearance the standard half-pound package. The administration was asked to consider the matter and take some action, if the facts warranted.

The reports received indicated that the practice was carried on more extensively in a few of the Eastern States and larger cities than elsewhere. A field investigation was made, and it was found that certain packers were distributing sliced beef and bacon in so-called odd-ounce packages. Some of these containers were found to simulate closely in dimensions and outward appearance the half-pound and 1-pound packages customarily merchandised by the majority of the packers in the industry. The true weight was in all cases marked on the odd-ounce package.

Petitions were received from a very large number of retail meat dealers, associations of retailers, packers, and packers' organizations, condemning the practice and urging action. On April 8, 1927, by invitation from the administration a number of representatives of packers, retail dealers, and others met in Washington for the purpose of discussing the question and arriving at a consensus of opinion as to the attitude of the trade toward the problem. A thorough discussion based on the practical knowledge and opinions of those engaged in the business was had. As a result, the following resolution was prepared and adopted with but one dissenting vote:

Whereas there now exists and for some time has existed among manufacturers and distributors of sliced bacon and sliced dried beef the practice of packing in cartons and packages odd-ounce quantities of these products; and

Whereas this practice is becoming so widespread that any manufacturer or distributor desiring to compete in various markets in the United States is compelled as a matter of self-protection to adopt the practice above described; and

Whereas the practice of selling an odd-ounce package or carton has been condemned by various retailers, wholesalers, and packers, as well as cooperative-buying organizations throughout the country; and

Whereas various packers, wholesalers, and retailers have expressed in various ways their approval of the standardization of packages of sliced dried beef and bacon in units of 8 and 16 ounces for bacon, and 4, 8, and 16 ounces for dried beef; and

Whereas since the departments of the United States Government have in the public interest been endeavoring to standardize various containers. Now therefore be it

Resolved, It is the sense of this meeting that merchandisers of these products should lend their aid to the Government's standization program; and be it

Further resolved, That it is the sense of this meeting that it is for the best interests of the consuming public, as well as for all parties at interest, that the package of sliced dried beef and bacon should be standardized so that sliced bacon shall be packed in packages of 8 and 16 ounces, and sliced dried beef in packages of 4, 8, and 16 ounces as units to be passed out to the consumer, and that we recommend to the Packers and Stockyards Administration that they use their efforts to secure the cooperation of all distributors and packers of dried beef and bacon to accomplish this end.

Since the resolution was adopted all packers, save one, who had engaged in the practice of packing sliced bacon in odd-ounce packages have discontinued the practice and have returned to the standard half-pound and 1-pound sizes, or have agreed to do so immediately upon the exhaustion of the supply of containers on hand.

It is believed that eventually the entire industry will adhere to the established custom of preparing and distributing dried beef and bacon in units based on the standard pound. This should prove beneficial to the manufacturer and consumer alike by the elimination of a multiplicity of sizes and types of packages and the removal of any possibility of consumers being deceived by the purchase of packages which contain less than the amount to which they have become accustomed.

RATES AND CHARGES

There are frequent changes in schedules filed by the stockyard companies as a result of changes in the market price of feed. A number of stockyard companies have also made increases in their charges for handling livestock arriving other than by rail. All these changes in schedules are scrutinized carefully for the purpose of determining whether the changes appear to be justified.

As a result of the Secretary's order in the St. Paul rate case, Docket No.

116, plans have been made for an extensive study of the rates at a number of the leading markets. The purpose of this investigation will be to develop not only the facts with reference to the operations of a local market but also those factors which influence the competitive relations, if any, which exist between the various markets. The regular program of making valuations of stockyard properties will be continued and appraisals made at those markets where no valuations have yet been made. In addition to the information relative to the value of the property devoted to the rendering of stockyard services, there will be a careful study made of the character of the service performed by the different yards. In determining the value of the service to the shipper it is believed that a comparison of the efficiency of the service rendered in the physical handling and feeding of livestock is an important factor. As a part of this general program a study of the past history and operations as well as the organization and growth of the various stockyards will be made. Since there are certain producing territories which are more or less competitive in nature, it is planned to make thorough study of the flow of livestock through the public markets and the trade territory from which the livestock comes. This will involve a careful analysis of the origin and flow of livestock receipts at the various public markets. This is a rather extensive program when it is considered that such information will be assembled with respect to a number of large markets. In the procedure heretofore followed in connection with rate investigations much of this information has already been collected with respect to certain markets. After all this preliminary work has been done it is believed that adequate material will be in hand to furnish a basis for the fixing of rates at a number of the markets, giving due consideration to the varying conditions that exist with respect to each market.

Following the close of the hearing in the Omaha commission-rate case a force of auditors was sent to Sioux City for the purpose of making a preliminary audit of the operations of the market agencies at that market, preparatory to a hearing scheduled to be held in connection with dockets Nos. 147 and 151. This preliminary investigation was completed and the material prepared. However, no further action was taken in connection with these cases or other pending commission-rate cases, nor have any subsequent investigations been made. Further action in this connection has been suspended until the final determination of the proceedings pending in court relative to the Secretary's order in the Omaha commission-rate case, docket No. 143.

AUDITS AND ACCOUNTS

PACKERS

Reports were received from 514 packers. These reports summarized indicate that 356 plants were Federally inspected and 158 were not Federally inspected. Of the 356 Federally inspected plants, 198 plants slaughter livestock, and 158 do not. Of the 158 non-Federally inspected plants 141 slaughter livestock, and 17 do not.

Table 2 shows for the year 1925 the number of each kind of livestock slaughtered and the total number of all kinds slaughtered by the 198 Federally inspected and 141 non-Federally inspected slaughtering concerns, from which reports were received. It also shows the percentage of slaughter represented by these concerns as compared with the total of federally inspected slaughter as reported by the Bureau of Animal Industry.

TABLE 2.—*Total inspected slaughter of livestock for year 1925, compared with slaughter by 339 firms reporting under packers and stockyards act*

Kind of livestock	Total inspected slaughter	Federally inspected slaughter, 198 firms	Non-Federally inspected slaughter, 141 firms	Relation of inspected slaughter, 198 firms, to total inspected slaughter (per cent)
Cattle	9,853,039	9,484,764	565,202	96.26
Calves	5,352,561	4,836,999	318,450	90.37
Hogs	43,042,867	42,279,452	1,863,868	98.23
Sheep	12,039,004	11,805,213	737,023	98.06
Total	70,287,471	68,406,428	3,484,543	97.32

The administration has required that reports from packers contain certain essential information as to the business operations. This information includes balance sheets, statements analyzing surplus, profit and loss statements, net sales, and inventories, as well as pertinent statistical data with reference to livestock purchases. These reports are carefully compiled, and in Table 3 is shown a consolidated statement prepared from the individual reports.

TABLE 3.—*Comparison of the operations of packing concerns for the years indicated*

Item	Values of 494 concerns in 1923	Values of 525 concerns in 1924	Values of 514 concerns in 1925
Total net worth	$855,023,061.72	$889,919,109.81	$934,597,238.59
Total income	3,109,048,602.16	3,321,964,071.23	3,807,988,473.83
Total expense	3,038,180,030.58	3,245,075,724.89	3,743,430,226.78
Net gain	70,868,571.58	76,888,346.34	64,558,247.05
Relation of returns to net worth, per cent	8.28	8.63	6.90

STOCKYARDS COMPANIES

Reports were received from 62 stockyards companies covering their operations for the year 1925. Table 4 is a compilation from these reports, compared with reports for 1924.

TABLE 4.—*Summary of reports from 62 stockyard companies for the year 1925, compared with reports for 1924*

Item	Values in—	
	1925	1924
Total net worth	$115,802,165.28	$116,328,647.91
Gross income	37,406,167.04	30,793,413.20
Net profit	6,672,982.78	7,440,867.08
Relation of net profit to net worth, per cent[1]	5.76	6.40

[1] The above percentages show the rate of return on book value and are an average for the 62 reporting companies.

LIVESTOCK COMMISSION COMPANIES

Reports were received from 720 market agencies located at 52 marketing points, covering operations for 1925. These reports have been classified as shown in Table 5.

TABLE 5.—*Reports from market agencies, 1925*

Agencies	Number of agencies reporting—	
	For the full year	For part of the year
Old-line concerns	567	106
Cooperative concerns	25	6
Horse and mule concerns	8	8
Total	600	120

The receipts of livestock consigned for sale on the 52 markets referred to totaled 72,191,178 head. Of this number, 10,639,299 head, or 14.74 per cent, were handled by cooperative-marketing concerns.

The total commissions received, including those received by cooperatives, amounted to $23,417,623.63.

TRADERS AND ORDER BUYERS

Reports were received from 529 traders and order buyers covering their operations for the year 1925, of which 314 contained sufficient details to be used for statistical purposes. These 314 reports were from 209 cattle traders, 69 hog traders, 30 sheep traders, and 30 order-buying concerns. Where a trader handled more than one species of livestock, such trader was considered separately with respect to each species. This results in an apparent discrepancy between the number of reports and the number of traders involved.

AUDITS COMPLETED

The number of concerns audited and reported on during the years 1925 and 1926 and the first six months of 1927 are shown in Table 6.

The reports covering the calendar year 1926 indicated that 30 concerns were in a weak financial condition and that 144 concerns were underbonded.

The 63 reports and investigations completed during the first six months of 1927 indicated that 19 concerns were underbonded and that 5 were in a weak financial condition. Appropriate action was taken to correct the unsatisfactory conditions.

TABLE 6.—*Concerns audited and reported on, in stated years*

Concerns	Number of concerns reported on—		
	In the calendar year 1925	In the calendar year 1926	In the 6 months Jan. 1 to June 30, 1927
Stockyard companies	32	29	13
Livestock commission concerns:			
Financial audits	142	322	43
Trade practice audits	99	37	4
Weak financial condition	24	37	1
Order buyers and dealers:			
Financial audits	47	8	
Trade practice audits	32	40	2
General reports	17	5	
Total	393	478	63

ACTIONS IN COURT PERTAINING TO THE PACKERS AND STOCKYARDS ACT

The case of Cudahy Packing Co. *v.* United States, 15 F. (2d), 133, decided by the Circuit Court of Appeals October 27, 1926, dealt with the question as to whether the Secretary of Agriculture had authority to inspect the books, records, memoranda, and correspondence of the packers where no proceeding was pending. The lower court upheld the secretary. The Circuit Court of Appeals for the Seventh Circuit reversed the lower court. The court in referring to the Stafford *v.* Wallace case, 258 U. S. 495, said that the Supreme Court held that stockyards, as well as commission men and traders, were within the regulatory power of Congress. The court then pointed out that "the act respecting stockyards is quite similar in scope to the interstate commerce act (Comp. St., sec. 8563 et seq.) respecting carriers." The court held, however, "respecting packers there are no such provisions." It was then held, "we can not see wherefore the unlimited inspection of books, records, memoranda, and correspondence without process of law in some pending proceeding, respecting every detail and relation of an interstate business, is any the less unreasonable in the case of the packers under the packers and stockyards act than in the case of corporations generally subject to the jurisdiction of the Federal Trade Commission, and we perceive no reason wherefore the cited authorities respecting cases arising under the Federal trade commission act are not here applicable and binding."

The Department of Justice filed a suit in the district court at Chicago, Ill., against the B. S. Pearsall Butter Co. for $16,000, which represented accrued penalties under the act for failure of that company to file an annual report with the Secretary. A general demurrer was filed by the defendant, and the case was set down for argument before Judge Cliffe and was argued June 10, 1927. The court directed attorneys for both parties to file briefs. The case is now pending.

In re The American Live Stock Commission Co. et al. *v.* The Secretary of Agriculture, involving market agencies at Oklahoma City, the Secretary's hearing was held in June–August, 1925, under docket No. 136, as a result of which the Secretary's cease and desist order issued. On April 23, 1926, there was served on the Secretary of Agriculture a bill seeking to enjoin the Secretary from enforcing his order. It is expected that this case will be heard in September or October, 1927.

By order of June 30, 1924, the Secretary prescribed reasonable rates for stockyard services to be charged by the Peoria Union Stock Yards Co. These charges were as follows:

	Cents per head
Cattle	22
Calves	11
Hogs	7½
Sheep	6
Horses	22

This represented a 25 per cent reduction on the yardage charges. The order also fixed a definite differential between the market price of feed and the price to be charged by the stockyards company.

The Peoria Union Stock Yards Co. asked the District Court of the Southern District of Illinois to enjoin the Secretary from enforcing this order. After a hearing on the request for a temporary injunction the injunction was issued on July 16, 1924, on condition that all the charges prescribed by the Secretary for yardage and feed be complied with, with the exception of the rate on hogs, which was raised to 9 cents per head. It was further ordered that this order remain in effect only during the pendency of this cause or until the charges mentioned were otherwise fixed as provided by law.

By consent of all parties in this proceeding the following decree was entered by the court on November 8, 1926:

IT IS ORDERED, ADJUDGED, AND DECREED:

1. That on motion of the plaintiff, the Hon. William M. Jardine, successor in office to Henry C. Wallace as Secretary of Agriculture of the United States, and Walter M. Provni, successor in office to Thomas Williamson as United States attorney in and for the southern district of Illinois, be made parties defendant to this suit, in substitution for the said Henry C. Wallace, deceased, and the said Thomas Williamson, resigned.

2. That the Secretary of Agriculture be and is hereby enjoined and restrained from enforcing that part of a certain order promulgated by the Hon. Henry C. Wallace as Secretary of Agriculture on the 30th day of June, 1924, by which the plaintiff is prohibited from publishing, demanding, or collecting any rate or charge in excess of 7½ cents per head for yarding of hogs in the Peoria Union Stock Yards at Peoria, Ill.; but only upon condition that the plaintiff from the date of this order charge for yarding such hogs not more than 9 cents per head.

3. That as to the remaining portion of the aforesaid order of the Secretary of Agriculture an injunction is denied.

4. That nothing herein shall affect any right of the plaintiff to fix new rates or charges, or of the Secretary of Agriculture to act with reference to the same, as provided in Title III of the aforesaid packers and stockyards act, 1921.

The Secretary's order in docket No. 143, the Omaha commission rate case, prescribed a schedule of rates materially lower than those in effect. Three of the respondent commission firms on behalf of themselves and all other persons, firms, or corporations engaged in the livestock-commission business at the Omaha market who were similarly situated and wished to join in the bill petitioned the District Court of the United States of the District of Nebraska for an injunction against the Secretary of Agriculture and the Attorney General of the United States against the enforcement of the order. By consent of all parties the following temporary injunction was issued by the court on December 31, 1926:

It is ordered that the defendants, William M. Jardine, Secretary of Agriculture of the United States, John G. Sargent, Attorney General of the United States, and James C. Kinsler, United States attorney for the district of Nebraska, and each of them, their successors, officers, employees, and agents be and they are hereby enjoined and restrained, until the further order of this court, from enforcing or attempting to enforce or to put into operation, any rates, tariffs, or charges in respect to the services of plaintiffs herein as market agencies, operating upon the Union Stockyards of Omaha, Nebr., based on a certain order promulgated by defendant, William M. Jardine, as Secretary of Agriculture, November 19, 1926, docket No. 143, in re The Secretary of Agriculture *v.* American Livestock Commission Co. et al., and from instituting or prosecuting any proceedings of any kind to enforce against plaintiffs, their officers, agents, or employees, or any of them, any fines or penalties for failure to comply with any order or orders of defendants, based upon said order of November 19, 1926.

The right is reserved to the defendants to apply to the Hon. Joseph W. Woodrough, United States district judge for the district of Nebraska, for an order which will guarantee the repayment by plaintiffs to their patrons of any charges collected by them during the pendency of this litigation in this court and upon appeal, in excess of the rates fixed by the Secretary of Agriculture in his said order of November 19, 1926, in the event that said rates are finally sustained. And the said judge shall have power to make such order in the premises as, after hearing of both parties, seems to him equitable.

Upon the full observance by plaintiffs, respectively, of such order, if and when issued, the continuance of this temporary injunction as to each of such plaintiffs, respectively, is hereby conditioned. The term plaintiff wherever used in this order shall include all market agencies affected by the aforesaid Secretary's order.

The case came on for final hearing on March 15, 1927. The Government's motion that the court require the petitioners to furnish bond covering the difference between the rates being charged and the rates prescribed by the Secretary's order was denied. The petitioners' motion that the case be referred to a master for the purpose of taking additional evidence was granted. A special master was appointed, and the additional evidence was taken before him on June 16 to 21, 1927.

OPINION OF THE ATTORNEY GENERAL

Under date of March 18, 1926, the Attorney General rendered an opinion in response to a request from the Secretary on the question whether the term "dealer" as defined in the act includes persons regularly employed on salary by packers to buy livestock at a stockyard for the latter for slaughter. The Attorney General concluded the opinion as follows:

It seems equally or more desirable, indeed, that packer buyers, as well as packers, should be included within section 301 (d), especially in view of the probable purpose of the registry requirements in section 303. It is equally important that sellers of livestock should be able to verify from the public records the identity and standing of employee buyers with whom they must deal as of the principal buyers themselves. Otherwise impostors might deceive them by posing as the agents of responsible principals, from whom in reality they held no authority.

I must therefore advise you, in response to your inquiry, that in my opinion the term "dealer," as defined in section 301 (d), Title III of the packers and

stockyards act, 1921, includes persons regularly employed on salary by packers to buy livestock in commerce at a stockyard for the latter for slaughter.

PROPOSED AMENDMENTS TO THE ACT

At the last session of Congress recommendations were made by the department relative to several proposed amendments to the act. Among them was the amendment of the term "dealer," so that the term "dealer" would mean any person engaged in the business of buying or selling in commerce livestock, other than on a commission basis, at a stockyard, whether for purposes of slaughter or otherwise. By inserting the phrase "for the purposes of slaughter" the act would manifestly cover a so-called "packer buyer" and thereby prevent any possible question arising as to all provisions of the act concerning dealers applying to packer buyers. For several years a provision authorizing the Secretary to require bonds from market agencies and dealers has been inserted as a rider in connection with the appropriation for the enforcement of the act, and it is proposed to make this permanent legislation. Another proposed amendment is to cast the burden of proof upon the market agency or stockyard owner who files with the Secretary any new rate or charge. The provision now contained in the rider to the appropriation act authorizes the Secretary to suspend a market agency or dealer that violates the act or becomes insolvent. This provision is incorporated in a new section known as 317 of the act. This new section will also give the Secretary the right to take appropriate action in connection with any officer, agent, or employee of a market agency or dealer, as he may now do with such officer, agent, or employee's principal. Section 401 of the act would be amended so as to give the Secretary or his duly authorized agent or agents access at all reasonable times for the purpose of examination, and the right to copy any accounts, records, and memoranda of any packer, stockyard owner, market agency, or dealer. These proposed amendments were incorporated in a bill introduced in the Senate on January 14, 1927, by Senator Kendrick, known as S. 5267.

Another amendment was proposed by a number of livestock organizations and was introduced in the Senate at the last session. This bill, known as S. 4387, seeks to authorize the Secretary to designate as terminal livestock markets stockyards posted by him. It provides that:

> No stockyard shall be designated by the Secretary of Agriculture as a terminal livestock market upon which there has been handled or sold in interstate commerce during the preceding year less than three million head of livestock.

Under such designation no packer purchasing livestock thereon for slaughter at a packing plant operated by such packer shall purchase or acquire in commerce, except at a stockyard posted by the Secretary under this act, livestock for slaughter at any such packing plant through the use, ownership, operation, or control, directly or indirectly by it or through any subsidiary of any place, establishment, or facility where stockyard service or services as defined in this act, or service or services in connection with the receiving, buying, selling, marketing, feeding, watering, holding, delivery, shipment, weighing, or handling, in commerce, of livestock directly from the producer or his agent where title to such livestock is acquired and paid for by the packer prior to shipment thereof to the packer by the producer or his agent. Hearings were held during January, 1927, on this bill.

None of the foregoing amendments passed Congress during the last session. It is presumed that these various amendments will receive consideration at the next session of Congress.

INDEX TO FORMAL DOCKETS

PENDING MARCH 30, 1926

Docket No.	Subject	Market	Status
6	Stockyard rates	Omaha, Nebr	Pending.
7	do	Chicago, Ill	Do.
9	Commission rates	Portland, Oreg	Do.
24	Stockyard rates	Pittsburgh, Pa	Dismissed.
83	Commission rates	Oklahoma City, Okla	Pending.
116	Stockyard rates	South St. Paul, Minn	Dismissed.
132	Commission rates	National Stock Yards, Ill	Pending (122, 123, 124, consolidated with 132).

INDEX TO FORMAL DOCKETS—Continued

PENDING MARCH 30, 1926—Continued

Docket No.	Subject	Market	Status
136	Trade practice	Oklahoma City, Okla	Cease and desist order as to part of respondents; dismissed as to others.
141	Solvency	Kansas City, Mo	Suspension.
143	Commission rates	Omaha, Nebr	New rates prescribed.
145	Solvency	Milwaukee, Wis	Pending.
147	Commission rates	Sioux City, Iowa	Do.
148	Solvency and trade practice	Chicago, Ill	Cease and desist order. Found to be solvent.
149	do	do	Suspension.
150	do	do	Do.
151	Commission rates	Sioux City, Iowa	Pending.

INSTITUTED MARCH 30, 1926, TO JUNE 30, 1927

152	Trade practice	Chicago, Ill	Pending.
153	Stockyard rates	Fort Worth, Tex	Tariff withdrawn and dismissed after new tariff filed.
154	Trade practice	South St. Paul, Minn	Cease and desist order and suspension.
155	Stockyard rates	Fort Wayne, Ind	Dismissed.
156	Solvency	South St. Joseph, Mo	Suspension.
157	do	do	Do.
158	do	Omaha, Nebr	Dismissed—respondent retired from business.
159	Bond	Chicago, Ill	Pending.
160	do	do	Do.
161	Trade practice	Cincinnati, Ohio	Cease and desist order.
162	do	do	Dismissed.
163	Solvency	Baltimore, Md	Dismissed—respondent retired from business.
164	Bond	National Stockyards, Ill	Cease and desist order.
165	do	do	Do.
166	Stockyard rates	Kansas City, Mo	Pending.
167	Bond	National Stockyards, Ill	Cease and desist order.
168	do	do	Do.
169	do	do	Do.
170	do	do	Do.
171	do	do	Do.
172	do	do	Cease and desist order and suspension.
173	do	do	Do.
174	do	do	Do.
175	Reparation	Chicago, Ill	Dismissed on motion of complainant.
176	Bond	Indianapolis, Ind	Cease and desist order.
177	Trade practice	South St. Paul, Minn	Do.
178	Bond	Indianapolis, Ind	Do.
179	do	do	Do.
180	Trade practice	Buffalo, N. Y	Cease and desist order and suspension.
181	Bond	Indianapolis, Ind	Do.
182	Trade practice	South St. Paul, Minn	Cease and desist order.
183	Bond	Omaha, Nebr	Dismissed.
184	Bond and trade practice	Kansas City, Mo	Cease and desist order and suspension.
185	Trade practice	Sioux City, Iowa	Dismissed.
186	Bond	Lancaster, Pa	Cease and desist order and suspension.
187	Stockyard rates	Peoria, Ill	Dismissed—tariff withdrawn.
188	Trade practice	Sioux Falls, S. Dak	Cease and desist order and suspension.
189	do	Buffalo, N. Y	Cease and desist order.
190	do	Sioux City, Iowa	Do.
191	Stockyard rates	San Antonio, Tex	Pending.
192	Solvency	Ogden, Utah	Do.
193	Reparation	Los Angeles, Calif	Do.
194	Trade practice	Buffalo, N. Y	Do.
195	do	Louisville, Ky	Do.
196	do	St. Joseph, Mo	Do.
197	do	Ogden, Utah	Do.

SUMMARY STATEMENT REGARDING FORMAL DOCKETS

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Instituted Mar. 30, 1926, to June 30, 1927	46
Final action taken Mar. 30, 1926, to June 30, 1927	43
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SUBJECT MATTER OF DOCKETS

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Bonds	18
Solvency and trade practices	3
Bonds and trade practices	1
Reparation	2

FORM OF ACTION TAKEN

Cease and desist orders	17
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Cease and desist orders and suspension	9
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FORMAL PROCEEDINGS

There follows a list of formal dockets wherein proceedings were instituted relative to violations of the act or reasonableness of rates and charges. This list includes all dockets pending as of March 30, 1926, and those instituted from that date to June 30, 1927, as indicated in the foregoing index. There is given in connection with each docket a brief synopsis, showing the subject matter and action taken.

FORMAL DOCKETS

Docket No. 6. Union Stockyards Co. of Omaha (Ltd.), South Omaha, Nebr.

This is a case involving a charge for livestock "planted and resold" in the commission division of the Union Stockyards Co., of Omaha, located at South Omaha, Nebr. The charge so assessed was equal to one-half of the yardage charge for yarding livestock and is commonly known as a "reweigh charge." Complaint was made to the Secretary that this charge was unjust, unreasonable, and discriminatory, under Title III of the packers and stockyards act. Upon the basis of this complaint and upon his own motion, the Secretary on June 8, 1922, ordered that a general inquiry be made into the yardage, feed, weighing, and other charges of the stockyards company, in order to determine a just and reasonable basis for establishing a tariff. A hearing, ordered by the Secretary, was begun on September 18, 1922 Upon the basis of the record the Secretary found the reweigh charge to be discriminatory. The company thereupon filed a tariff purporting to remove the discrimination. This tariff was later suspended also. The Omaha Stockyards Co. stipulated with the Secretary of Agriculture for an indefinite suspension of its tariff until the Chicago case could be decided. (See docket 7 following.)

On September 22, 1926, the stockyards company filed an application to have the stipulation for the suspension previously referred to set aside. Oral argument on this application was held before the Secretary at Kansas City, Mo., November 1, 1926. By his order of November 26, 1926, the Secretary set aside the stipulation suspending supplement No. 2 to tariff No. 2. A general inquiry into all rates is pending.

Docket No. 7. Union Stock Yards & Transit Co., Chicago, Ill.

This is a case involving the question of whether a reweigh charge is unreasonable and discriminatory against dealers in the Union Stockyards, Chicago. The case arose out of a complaint on the part of dealers engaged in buying and selling livestock on this yard.

Acting upon this complaint and upon his own motion, the Secretary of Agriculture on June 8, 1922, ordered that a hearing be held for the purpose of determining the question of whether a reweigh charge is unjust and discriminatory and on the reasonableness of all rates and charges for stockyard services. In accordance with this order a hearing was held beginning October 9, 1922. On June 22, 1923, a report, findings, and conclusion relative to the reweigh charge was made, and the Secretary ordered a discontinuance of this charge.

The stockyards company then filed a tariff purporting to remove the discrimination. This tariff was suspended, and further hearings were held. Upon the basis of the record the examiner recommended a decrease in the charges for stockyard services and suggested a differential between the cost of feed and the charges made for it to livestock shippers.

The case was argued before the Secretary on October 2, 1924, at Washington, D. C., and the parties were given three weeks in which to file written argument. Further hearings were held December 17 to 21, 1926, for the purpose of bringing the data in the record down to date. The case is now pending.

Docket No. 9. American National Livestock Association et al. *v.* The Market Agencies Operating at North Portland, Oreg.

The American National Livestock Association and others filed with the

Secretary on July 25, 1922, a petition against the market agencies operating at the Portland Union Stockyards, North Portland, Oreg., averring that commission charges for the sale and purchase of livestock were unjust, unreasonable, and discriminatory. The complaint contained also a request for reparation and a prayer for future relief from the charges declared to be unjust, unreasonable, and discriminatory. An answer was filed by the respondents on September 15, 1923, in which a general denial of all allegations of the complaint, except those relating to jurisdiction, was made. It seemed to the Secretary that there were reasonable grounds for investigating this complaint, and he, therefore, issued an order on May 20, 1924, that a proceeding be had under Title III of the packers and stockyards act for the purpose of allowing the parties to be heard.

A hearing was begun on July 22, 1924, before an examiner for the Packers and Stockyards Administration. On the basis of this record the examiner made a report of findings of fact and recommendation to the Secretary on November 10, 1924. The examiner found upon the basis of the record that the rates and charges being made at the time of the complaint were unreasonable and set forth a schedule of rates which, in his judgment, would be reasonable. The respondent filed exceptions to the report of the examiner on December 15, 1924, and an oral argument before the Secretary was requested. The case is pending.

Docket No. 24. Pittsburgh Union Stock Yards Co., Pittsburgh, Pa.

This is an inquiry into the rates and charges at the Pittsburgh Union Stockyards initiated by the Secretary by reason of a tariff filed on April 11, 1923, and to become effective April 22, 1923, increasing the price charged for corn. In addition to the inquiry into the reasonableness of the increased charges for corn, a general inquiry was ordered by the Secretary on May 31, 1923, into the reasonableness of all rates and charges at this yard. A hearing was held on June 18, 1923, and continued on March 25, 1924. The examiner issued his report and findings on October 14, 1924. The respondent filed exceptions to these findings on December 27, 1924, and requested an oral argument before the Secretary. Later a request was made by the respondent that another hearing be granted. The attorney for the Government also filed exceptions. A further hearing was held on June 17, 1926. The examiner issued his tentative findings on October 8, 1926. The case was dismissed without prejudice by order of the Secretary June 25, 1927.

Docket No. 83. Barefoot Livestock Commission Co. and other market agencies at Oklahoma City, Okla.

Acting in accordance with a complaint made by the Oklahoma Livestock Exchange, on behalf of its market-agency members, against the Bolinger-Spencer Livestock Commission Co., that the commission rates charged by the Bolinger-Spencer Co. were too low, the Secretary on February 29, 1924, issued an order of inquiry into the reasonableness of all rates and charges for buying and selling livestock at the Oklahoma City market. Hearings were held on April 8, 1924. The examiner issued his findings on July 21, 1924, to which exceptions were filed on October 3, 1924. This case is pending.

Docket No. 116. St. Paul Union Stockyards Co. rate cases.

On July 11, 1924, the Secretary issued an order directing that an inquiry and a hearing be held to determine the reasonableness of rates charged by the St. Paul Union Stockyards Co. for rendering stockyard services, naming August 7, 1924, as the date of the hearing. This hearing was postponed until September 30, 1924. Beginning on this date and continuing until October 17, 1924, the first hearing was held. The second hearing was held on November 17, 1924, and lasted until December 1, 1924. A third hearing was begun on July 21, 1925, and continued until August 8, 1925. A further hearing was held in this case from October 19 to October 26, 1925. The final hearing was held beginning December 8, 1925, in Washington, D. C. Oral argument was held before the Secretary December 13 and 14, 1926. On May 17, 1927, the secretary issued his order dismissing the case. The conclusion of the Secretary in arriving at this decision and his order are as follows:

Conclusion

The record in this proceeding was built upon the theory that respondent is entitled, through its rates, to earn a "fair rate of return" upon the "fair value" of its property, and no more. For the application of this theory it is well and sufficiently built, but I do not regard the theory as constituting a fair or adequate test of the reasonableness of stockyard rates.

The picture disclosed by the record and by departmental knowledge, which I can

not ignore, is of a stockyard fortunately located upon reasonably priced land at the outskirts of a city and not surrounded by highly industrialized land; a yard well and economically managed; rendering a service to the livestock shipper which must be characterized as very good; making upon what might reasonably be called "the fair" value of its property a return considerably above what the courts seem to consider the minimum nonconfiscatory return; paying interest and dividends considerably greater than are absolutely necessary to maintain its credit and to enable it to compete in the securities markets upon favorable terms; drawing constantly increasing receipts from a steadily developing agricultural section; and doing these things upon rates which, when yardage, feed, and bedding charges are considered together, are not higher than at any other stockyard of comparable size.

If, under these circumstances, the rates are to be regarded as unreasonable and unlawful because they yield more than a given percentage of net return upon the "fair value" of respondent's property, it must be for the reason that the packers and stockyards act, 1921, treats financial success, no matter how obtained, as an evil and seeks to prevent it. I do not so understand the act.

This is not to say that the reasonable cost of rendering the service may not be a large, even the controlling, factor in determining reasonable rates. It simply means that, in my opinion, a method which tests the reasonableness of the rates for each stockyard by the costs which it has developed and without reference to the cost of the same or quite similar service to other comparable yards tends to reward extravagance and bad management and to penalize economy and efficient management by allowing costs resulting from the former to justify high rates at one yard while the conditions brought about by the latter force the lowering or rates at another. Such a method would not accord with the course pursued by me in determining the reasonableness of livestock commission rates (the Omaha commission-rate case, docket 143) and does not seem to me to be the correct way of ascertaining the reasonableness of rates now in force or of establishing new and reasonable ones.

In this connection I call attention to the effect of unearned increment on land values in determining under the "fair value-fair return method" the reasonableness of rates. Contrast two yards. One located where it is most desirable it should be, namely, away from the congested area of a city. The other originally so located but around which there has grown an intense industrial development wholly unrelated to the livestock industry. Under the method here being discussed, materially higher rates at the latter than at the former might be justified, notwithstanding that its cost of operation is not greater, that its original cost of land and structures and its present capitalization was and is not more, and that it renders the shipper a much poorer service. In other words, it is an inescapable conclusion that in so far as stockyards are concerned the fortuitous circumstance of whether a city has or has not happened to grow around a stockyard is very apt to become the controlling factor in determining the reasonableness of its rates.

A median arrived at from consideration of the result of these and other factors upon the cost to each of a representative group of stockyards of rendering the service should, no doubt, be given great weight in determining reasonable rates for the services rendered at each. This was the course pursued in the Omaha commission-rate case (docket 143). But it seems to me that if each yard is dealt with separate and apart from all the others the probable final result will be that there will exist simultaneously at the various comparable yards schedules of rates prescribed by the Secretary of Agriculture as reasonable which will vary materially in altitude without any reason for such variance other than circumstances which have little, if any, connection with the service rendered or the real cost of rendering it.

The packers and stockyards act, 1921, does not empower me to prescribe any rates for a stockyard unless and until I shall have found the rate or rates adopted by it to be unreasonable. Respondent says that its rates are lower than those at any other comparable yard and that for this reason they are not unreasonable. There is considerable force to this argument even though, as hereinbefore stated, I am not satisfied that the St. Paul rates, taken as a whole, are materially lower than at the other comparable yards. Customarily, our opinion as to the reasonableness of any price is guided to quite an extent by the prices charged elsewhere for the same article or service.

It is true, of course, that all stockyard rates may be too high, and such a decision may be the outcome of the investigation hereinafter suggested. However, I can not but believe that if the method suggested by this record for testing the rates at St. Paul be applied in the same manner to those other stockyards, it will sustain the present rates at some and warrant higher rates at others. Whether or not this would be true would depend to quite an extent upon wholly extrinsic factors which have little, if any, relation to the real cost, value, or quality of the service rendered.

From the foregoing it is apparent that my conclusion is that the questions at issue in this proceeding, namely, the reasonableness of rates and charges contained in respondent's tariff No. 8, and if they be not reasonable, the determination of a schedule of rates and charges that are, can not fairly and justly be decided upon the present record until there be added thereto the result of a detailed study and investigation of the general stockyard-rate situation. Inasmuch as such investigation and study necessarily will cover a considerable period of time, I am of the opinion that the present proceeding should be dismissed without prejudice and subject to be reopened upon notice at such time as final disposition thereof may be made in conjunction with a general determination as to reasonable rates at this and other comparable stockyards.

It is ordered, therefore, that this proceeding be dismissed without prejudice and subject to be reopened upon order of the Secretary of Agriculture and due notice thereof to the respondent.

Dockets Nos. 122, 123, and 124. Nifong Commission Co., Independent Livestock Commission Co., J. E. Davis Livestock Commission Co., National Stock Yards, Ill.

This case grew out of the fact that certain commission companies filed schedules increasing commission rates. The Acting Secretary of Agriculture, on July 21, 1924, issued an order of investigation and hearing to determine the reasonableness of the increase. A hearing was held on August 11, 1924. These cases were later consolidated and made a part of docket No. 132.

Docket No. 132. Alexander, Conover & Martin, and other market agencies operating at the National Stock Yards, Ill.

On October 10, 1924, the Secretary ordered an investigation and hearing to determine the reasonableness of commission rates charged by the respondents. A hearing was held on March 24, 1925. This case is pending.

Docket No. 136. The American Livestock Commission Co., and others, National Stock Yards, Oklahoma City, Okla.

On May 18, 1925, an order of inquiry and a hearing was ordered by the Secretary to determine whether the respondents, market agencies and dealers, had individually and in concert engaged in and used unfair and unjustly discriminatory practices and devices in connection with the buying and selling of livestock in commerce for the purpose of driving out of business the Producers' Commission Association and the Bolinger & Spencer Livestock Commission Co., market agencies at the Oklahoma National Stock Yards. A hearing on this complaint was held beginning June 29, 1925. The examiner issued his findings on December 9, 1925, and exceptions were filed by the respondents. The case was argued before the Secretary on February 18, 1926. In his order, issued March 31, 1926, the Secretary of Agriculture ordered that the American Livestock Commission Co., the Barefoot Livestock Commission Co., Cassidy Southwestern Commission Co., Fuson Commission Co., Healy & Co., Ingram Livestock Co., Johnson-Laux-Campbell Livestock Commission Co., Liberty Livestock Commission Co., Midwest Livestock Commission Co., Oklahoma Livestock Commission Co., Scannell-Slitt Commission Co., the Stribling Commission Co., Ralph Sullivant, C. J. McFarland, J. E. Cash, W. J. Goodson, W. H. May, O. J. Jones, Ben Kapp, and Jean Pryor cease and desist from engaging in and using any unfair or unjustly discriminatory practices or devices in connection with the buying and selling of livestock in commerce at the Oklahoma National Stock Yards, as defined in the packers and stockyards act. He also ordered that the case be dismissed against the following parties: National Commission Co. (dissolved), a market agency formerly registered under the packers and stockyards act and doing business at the Oklahoma National Stock Yards, H. C. Aldridge, Ed. C. Baldrige, T. O. Bivin, J. S. Bogle, Ed Bohling, B. B. Clark, John Clark, W. E. Dabbs, C. E. Davis, T. J. Driggers, A. A. Hamilton, E. H. Johnson, W. H. Johnston, Brice L. Kendall, D. V. Lackey, W. T. Lobb, V. E. Long, Pat Maloy, jr., R. W. Martin, H. J. McCarron, J. F. McGrath, J. W. O'Quin, A. G. Pannell, T. J. Pannell, G. F. Patterson, E. G. Ramsey, H. C. Rice, E. C. Ridley, N. M. Scannell, Hurley Slitt, W. P. Spencer, Alex Steel, Fred Welter, Gilbert Wright, Kelly L. Wright, H. T. Wright, Ralph O. Wright, and Roger O. Wright; *provided, however,* that the dismissal of these proceedings against the above-named parties in their capacity as registered traders shall not in any way be construed as a dismissal of the charge against said parties or against any corporation, partner, or partnership with which they are now or were connected and which are registered and doing business as market agencies under the packers and stockyards act.

Docket No. 141. C. Olin Long, Kansas City Stock Yards, Kansas City, Mo.

On February 4, 1926, the acting secretary issued an order for investigation and hearing to determine whether the respondent was insolvent. The hearing was held on April 4, 1926, and on May 13, 1926, the secretary found the respondent to be insolvent and issued his order suspending the respondent for a period of one year.

Docket No. 143. American Livestock Commission Co.; Lou Bick Commission Co.; Bliss & Son; Bliss, Wellman & Hopkins; Boetel Livestock Commission Co.; Bowles Livestock Commission Co. of Omaha; and other members of the Omaha Livestock Exchange et al., Union Stockyards, Omaha, Nebr.

On January 16, 1926, the respondents published a tariff, effective January 26, 1926, stating a new schedule of rates and charges for buying and selling livestock. The charges as set forth in this schedule are greater than those under the one in force at the time of the filing of the increased rates. On January 25, 1926, the Secretary of Agriculture issued an order suspending this tariff for a period of 30 days beyond the time when it would otherwise have gone into effect, and directed an investigation and hearing to determine the reasonableness of the proposed commission rates. By order of the Acting Secretary, on February 20, 1926, this tariff was suspended for an additional 30-day period, and a hearing was commenced on March 25, 1926. Oral argument was had before the secretary on October 25, 1926, and on November 19, 1926, he ordered the respondents to cease and desist from continuing to collect charges in accordance with tariff No. 2 and to put into effect a new tariff.

The conclusion and order of the Secretary of Agriculture issued on November 19, 1926, gives the grounds upon which Tariff No. 2 was found to be unreasonable and sets forth the facts of record taken into consideration in arriving at the schedule prescribed.

The order states also the fundamental principle followed as a guide:

A schedule of commission rates is reasonable if it produces for that firm handling a reasonable volume of business in a reasonably efficient manner enough revenue per car to cover all reasonable operating expenses incident to handling it and a reasonable profit in addition.

A reasonable charge for handling a car of livestock based upon this principle does not become unreasonable because of the fortuitous circumstance of consignment to a firm prosperous on account of efficiency or volume of business resulting from efficiency.

On the other hand, such a charge per car does not become unreasonably low because it may have been consigned to a less prosperous firm with a smaller volume due to less efficiency.

As a result of the analysis of the business done by the respondent firms at Omaha in 1925, the following cost account was adjudged the reasonable cost of selling during the year a car of cattle, one of hogs, and one of sheep:

Item	Cattle	Hogs	Sheep
Yardmen's salary	$1.75	$1.50	$1.50
All other salaries	2.00	1.60	1.80
Travel, entertainment, advertising, etc	2.00	1.50	2.25
Overhead, including increased rental of $54,000	1.75	1.50	1.75
Exchange assessments and dues	.25	.25	.25
Total	7.75	6.35	7.55
Salesmanship	5.00	3.00	5.00
Interest	.50	.50	.50
Total cost	13.25	9.85	13.05

On the basis of this cost account the Secretary prescribed the following schedule of rates and charges to take effect not later than January 1, 1927:

SELLING SCHEDULE

	Head	Single deck	Double deck
Straight cars:	*Cents*	*Dollars*	*Dollars*
Cattle		15	
Calves		15	18
Hogs		12	18
Sheep		12	18
Mixed cars:			
Cattle	60	15	
Calves	30	15	18
Hogs	25	12	18
Sheep	20	12	18

Prorating.—In the case of those cars where prorating is necessary or requested an additional charge of 30 cents for each such proration. Minimum 60 cents and maximum $3 on any one car. When individual statements are requested, a charge of 5 cents extra for each statement.

Drafts.—In the case of those cars where more than three drafts are necessary or requested, 25 cents per draft in excess of three, maximum $3 on any one car.

Yard sales.

Cattle—60 cents per head, with a maximum of $15 up to and including each 30 head.

Calves—30 cents per head, with a maximum of $15 up to and including each 60 head.

Hogs—25 cents per head, with a maximum of $12 up to and including each 70 head.

Sheep—20 cents per head, with a maximum of $12 up to and including 150 head and 20 cents per additional head above 150, with a maximum of $18 up to and including each 300 head.

Drive-ins.

Cattle—70 cents per head.

Calves—425 pounds and below, 35 cents per head.

Hogs—30 cents per head.

Sheep—On each 300 head of sheep or fraction thereof in one consignment the rates shall be determined as follows: 20 cents per head, with a maximum of $12, up to and including 150 head; 20 cents per additional head above 150, with a maximum charge of $18, up to and including each 300 head.

BUYING SCHEDULE

Stocker and feeder cattle.

For purchasing stocker and feeder cattle $15 per car. When necessary to purchase and pick up a car from more than two owners, 50 cents per additional lot over two, maximum charge $18.

Cattle for immediate slaughter.

For purchasing cattle for immediate slaughter $12.50 per car. When necessary to purchase and pick up a car from more than two owners, 50 cents per additional lot over two, maximum charge $15.

When cattle are purchased for immediate slaughter for outside packers by their own buyers, market agencies merely clearing such transactions, $5 per car.

Calves.

Cattle schedule to apply. Cattle weighing less than 425 pounds considered calves.

Sheep.

For purchasing sheep $12 per single-deck and $18 per double-deck car. When double decks of sheep are purchased upon order and single-deck cars are furnished by the carrier for any reason, the commission charges to be based upon the double-deck rate.

For purchasing each 300 head of sheep or fraction thereof on one order to be driven or hauled out, the rates to be determined as follows: 20 cents per head with a maximum of $12, up to and including 150 head, and 20 cents per additional head above 150 with a maximum of $18, up to and including each 300 head.

Hogs.

Stocker and feeder hogs.—Single deck, $12; double deck, $18.

For purchasing each 150 stock hogs or fraction thereof on one order to be driven or hauled out, the rates to be determined as follows: 20 cents per head, with a maximum of $12, up to and including 75 head, and 20 cents per additional head above 75 with a maximum of $18 up to and including each 150 head.

Other hogs.—For purchasing hogs other than stockers and feeders, $8 per single-deck and $10 per double-deck car.

For purchasing each 125 head or fraction thereof of hogs on one order to be driven or hauled out, the rates to be determined as follows: 20 cents per head, up to and including 70 head, with a maximum charge of $8; and 20 cents per additional head above 70, with a maximum of $10 up to and including each 125 head.

For purchasing any livestock to be shipped in one car for more than one person, an additional charge of 25 cents per purchaser to be made.

All livestock purchased or paid for or ordered out or as to which assistance has been rendered by a market agency, its agents, or employees, whether made by or for a speculator, yard trader, farmer, or other person, to be deemed a purchase and charged for at the above rates.

A market agency may order out entire shipments of stock when it has sold to the shipper 50 per cent or more thereof.

The effective date of the order prescribing the above schedule was later postponed to February 1, 1927. On December 31, 1926, respondents obtained a temporary injunction in the United States District Court for the District of Nebraska, restraining the Secretary from putting this order into effect. The case came up before three judges of the United States District Court on March 15, 1927, and upon motion the case was referred to a master for the purpose of taking further testimony. The master began taking testimony on June 16, 1927. The case is still pending in the Federal court.

On July 3, 1926, the American Livestock Assocation, Wyoming Stock Growers Association, et al., petitioners, filed a complaint seeking reparation from the respondents to the amount that the charges provided for by respondent's Tariff No. 2 should exceed just and reasonable charges as determined by the secretary. No action has been taken on the petition for reparation.

Docket No. 145. James Kane, Milwaukee Stock Yards, Milwaukee, Wis.

On February 3, 1926, the Acting Secretary ordered an investigation and hearing to determine whether the respondent was insolvent. A hearing was held on April 28, 1926. The case is now pending.

Docket No. 147. The Secretary of Agriculture *v.* Flynn Commission Co. et al., Sioux City Stock Yards, Sioux City, Iowa.

On March 3, 1926, the Secretary ordered an investigation and hearing to determine the reasonableness of commission rates charged by the respondents. On May 10, 1926, the Secretary ordered that this docket be consolidated with Docket No. 151.

Docket No. 148. Joseph C. Coates, Union Stock Yards, Chicago, Ill.

On March 11, 1926, the Acting Secretary ordered an investigation and hearing to determine whether the respondent was insolvent, and also to determine whether the respondent had engaged in an unfair practice or device in connection with the buying and selling of livestock. A hearing was held on April 30, 1926, before an examiner, and on September 27, 1926, oral argument was had before the Acting Secretary. On October 11, 1926, the Acting Secretary found that the respondent was not insolvent, but that the respondent had engaged in an unfair practice or device in that he had received and cashed certain checks and used the proceeds therefrom for livestock sold by him, whereas said checks should have been delivered to and cashed by the market agency acting as a clearing agency for him, in accordance with the agreement existing between respondent and his clearing agency. The Acting Secretary ordered that the respondent cease and desist from engaging in said unfair practice and device.

Docket No 149. Ziv Livestock Commission Co., Union Stock Yards, Chicago, Ill.

On March 11, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was insolvent and alleging that the respondent had engaged in an unfair practice and device in connection with the buying and selling of livestock on a commission basis, in that it had diverted the net proceeds of various sales of livestock made by it as a market agency to the payment and discharge of obligations other than those rightfully due and owing to the owners of livestock sold by the respondent, and for disbursing the proceeds in payments of its general obligations the respondent had issued to the respective owners of livestock worthless checks to cover the payment of the amounts due them as proceeds of the sales for said livestock. On March 15, 1926, the respondents admitted the truth of the charges and waived an oral hearing. On May 29, 1926, the

Acting Secretary issued an order suspending the respondent from registration for a period of six months.

Docket No. 150. James J. Flanagan and Arthur G. McGurk, doing business under the name of Flanagan & McGurk, Union Stock Yards, Chicago, Ill.

On March 11, 1926, the Acting Secretary ordered an investigation to determine whether or not the respondents had engaged in an unfair practice or device and to determine the solvency of the respondents. A hearing was held on April 29, 1926. The evidence showed that the respondents purchased livestock from a trader whose business was cleared through a market agency; and that it was the universal custom for persons who made purchases from a dealer whose business was cleared through a market agency to pay the clearing agency direct for such purchases. Contrary to this custom, at the request of the bookkeeper for the clearing agency, respondents made partial payment direct to the trader. The evidence also showed the respondents to be insolvent. By his order of October 18, 1926, the Acting Secretary suspended respondents for a period of six months. The order further provided that proceedings on the allegations of unfair practice be held in abeyance until such time as respondents resume business as a market agency.

Docket No. 151. Brown-Mattingly Co. et al., Sioux City Stock Yards, Sioux City, Iowa.

On or about March 9, 1926, respondents made and published, effective March 31, 1926, and filed with the Secretary a new schedule of rates and charges designated as Tariff No. 3. On March 24, 1926, the Acting Secretary ordered suspension of said tariff and ordered an investigation of the reasonableness and lawfulness of said new rates and charges, which were materially different and greater than those set forth in their schedule in force at the time of the filing of said Tariff No. 3. A hearing was set for April 30, 1926. On April 26, 1926, the hearing was postponed until May 24, 1926, and the suspension of Tariff No. 3 was extended for a further period of 30 days. On May 10, 1926, the Acting Secretary ordered that dockets 147 and 151 be consolidated, it appearing that the issues involved in each of these dockets were sufficiently similar to warrant their consolidation for the purpose of the hearing. On May 17, 1926, the hearing was postponed until June 28, 1926, and on June 17, 1926, the date of the hearing was postponed until further notice. The case is now pending.

Docket No. 152. Chicago Packing Co., Union Stock yards, Chicago, Ill.

On April 15, 1926, the Secretary issued complaint against respondent, alleging that it had engaged in unfair, discriminatory, and deceptive practices and devices in that in violation of a certain contract which it had entered into with the Chicago Livestock Exchange with reference to the handling of livestock infected or supposed to be infected with tuberculosis or other diseases, respondent withdrew certain dressed carcasses from competitive bidding and purchased the same at less than the true market value thereof. Complaint further alleges that respondent abstracted from its coolers certain carcasses which should have been offered for sale to competitive purchasers and substituted in lieu thereof carcasses lower in grade and inferior in quality, which inferior carcasses were sold to competitive bidders under the terms of the contract previously mentioned. By this device respondent acquired large quantities of meat superior in quality, grade, and value to that substituted in lieu thereof, to the damage and injury of the owners. Hearings in this case were postponed because of the fact that a criminal indictment was brought against the corporation and certain of its officers. The case is being held in abeyance pending the conclusion of those proceedings.

Docket No. 153. Fort Worth Stock Yards Co., Fort Worth, Tex.

As the result of the filing by respondent of its supplement No. 5 to tariff No. 3, effective May 6, 1926, the Acting Secretary on May 5, 1926, ordered an investigation to determine the reasonableness and lawfulness of certain provisions contained therein, and hearing was set for July 15, 1926. Hearing was postponed to August 10 and later was postponed indefinitely. After several conferences with representatives of the respondent, a new tariff was filed in which the objectionable features of supplement 5 to tariff 3 were eliminated, and on September 3, 1926, the case was dismissed.

Docket No. 154. R. R. Lewis, St. Paul Union Stockyards, South St. Paul, Minn.

On May 7, 1926, the Acting Secretary issued an inquiry and notice of hearing alleging that the respondent had engaged in unfair, unjustly discriminatory, and deceptive practices

or devices in that he had charged, demanded, or collected a greater or different compensation for his services as a market agency than the rates and charges specified in his schedule filed and in effect. Respondent admitted the charges and waived hearing. On June 8, 1926, a cease and desist order was issued, and respondent was suspended from registration for a period of one year. This suspension was revoked on December 18, 1926, effective January 1, 1927.

Docket No. 155. Fort Wayne Union Stock Yards Co., Fort Wayne, Ind.

On May 15, 1926, respondent made and published, effective May 31, 1926, amendment No. 3 to its Schedule No. 2, which provided for certain increases in the rates or charges for yardage over and above the tariff previously in effect. On June 3, 1926, the Secretary suspended the operation of said amendment for a period of 30 days beyond the time when it would otherwise go into effect, and ordered an investigation into the reasonableness and lawfulness of the rates and charges provided for by said amendment. Hearing was held on June 21, 1926. On the basis of the facts disclosed by the record, the Acting Secretary was of the opinion that the increase was not unreasonable and, therefore, on October 16, 1926, the case was dismissed without prejudice.

Docket No. 156. Herbert Dugdale, St. Joseph Stock Yards, South St. Joseph, Mo.

On June 3, 1926, the Acting Secretary issued an inquiry alleging respondent to be insolvent. Hearing was held on July 27, 1926, and respondent having been found to be insolvent, the Acting Secretary by his order of August 21, 1926, suspended respondent from registration for a period of six months, with the privilege of applying for a revocation of this suspension upon a satisfactory showing of solvency.

Docket No. 157. John Dugdale, St. Joseph Stock Yards, South St. Joseph, Mo.

On June 3, 1926, the Acting Secretary issued an inquiry alleging respondent to be insolvent. Hearing was held on July 27, 1926, and respondent having been found to be insolvent, the Acting Secretary by his order of August 21, 1926, suspended respondent from registration for a period of six months, with the privilege of applying for a revocation of this suspension upon a satisfactory showing of solvency.

Docket No. 158. Fred Signall, trading and doing business as the Independent Livestock Commission Co., Union Stockyards, South Omaha, Nebr.

On June 16, 1926, the Acting Secretary issued inquiry and notice of hearing for the purpose of determining the solvency of the respondent. Respondent having voluntarily retired from business, the case was dismissed without prejudice by order of the Acting Secretary on October 2, 1926.

Docket No. 159. Howard S. Turner, Union Stock Yards, Chicago, Ill.

On July 3, 1926, the Secretary issued an inquiry alleging that the respondent was a dealer within the meaning of the packers and stockyards act, 1921, and that the respondent was engaging in business upon the Union Stock Yards, Chicago, Ill., and that respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain a sufficient bond as required by the terms of the act. On July 19, 1926, respondent filed its answer. The answer not being such that the case could be disposed of on the complaint and answer, the respondent was given an opportunity to file a supplemental answer. Steps are being taken to bring the case to a conclusion.

Docket No. 160. Roberts & Oake, Union Stock Yards, Chicago, Ill.

On July 3, 1926, the Secretary issued an inquiry alleging that the respondent was a dealer within the meaning of the packers and stockyards act, 1921, and that the respondent was engaged in business on the Union Stock Yards, Chicago, Ill., and that respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain a sufficient bond, as required by the terms of the act. On July 19, 1926, respondent filed its answer. The answer not being such that the case could be disposed of on the complaint and answer, the respondent was given an opportunity to file a supplemental answer. Steps are being taken to bring the case to a conclusion.

Docket No. 161. J. N. Richey, W. R. Richey, and W. G. Shaffer, trading and doing business as J. N. Richey & Co., Cincinnati Union Stock Yards, Cincinnati, Ohio.

On July 10, 1926, the Acting Secretary issued an inquiry alleging that the respondents refunded or remitted a portion of the rates and charges specified in the respondent's tariff. The respondents admitted the acts alleged in the inquiry and waived an

oral hearing. On August 13, 1926, the Acting Secretary issued a cease and desist order.

Docket 162. C. C. Seal, doing business as C. C. Seal & Co., Union Stock Yards, Cincinnati, Ohio.

On July 14, 1926, the Acting Secretary issued an inquiry alleging that the respondent had engaged in an unfair practice in that he had weighed up a certain lot of hogs to his own account at $10 per hundredweight, whereas he had represented to the owner of said hogs that these hogs were sold to a bona fide purchaser, and that since the hogs were not in good condition for holding over for the following day's market, $10 per hundredweight was the highest price that he could secure for said hogs. Complaint further alleges that the respondent after having purchased said hogs for his own account sold them for $13.85 per 100 pounds, and that by reason of this transaction respondent had violated his duty as a market agency to the damage and injury of the owner of said hogs.

Hearing was held on September 9, 1926. Upon evidence adduced, the Acting Secretary found that the testimony of the shipper upon which the allegations in the inquiry were based was not in accordance with the facts alleged in his complaint; that the respondent by his agent had not falsely represented to the shipper that he had received an offer of 10 cents per pound for the hogs, but nevertheless that respondent did not fairly and fully disclose to the shipper the fact that he intended to weigh the hogs to himself. Case was dismissed by the Acting Secretary on May 5, 1927, upon the basis that the evidence was insufficient to substantiate the allegations of the violations of the act.

Docket No. 163. Sundheimer Livestock Commission Co. (Inc.), Union Stock Yards, Baltimore, Md.

On July 16, 1926, the Acting Secretary issued an inquiry and notice of hearing for the purpose of determining the solvency of the respondent. The respondent having ceased to do business and the firm being dissolved, the case was dismissed on February 9, 1927.

Docket No. 164. Daniel P. Collins, National Stock Yards, Ill.

On July 24, 1926, the Acting Secretary issued an inquiry and notice alleging that respondent was a market agency engaging in business on the National Stock Yards, Ill., and that respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his obligations incurred as a market agency, contrary to and in violation of the provisions of the packers and stockyards act.

After the issuance of this inquiry, it having been determined that respondent was improperly registered as a market agency, the case was dismissed by the Acting Secretary on September 13, 1926.

Docket No. 165. E. T. Cash, trading and doing business as E. T. Cash & Co., National Stock Yards, Ill.

On July 26, 1926, the Acting Secretary issued an inquiry and notice alleging that respondent was a market agency and dealer engaging in business on the National Stock Yards, Ill., and that respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his obligations incurred as a market agency and dealer contrary to and in violation of the provisions of the packers and stockyards act.

Hearing was held on September 10, 1926, and on October 14, 1926, a cease and desist order was issued.

Docket No. 166. Traders Livestock Exchange et al. *v.* The Kansas City Stock Yards, Kansas City, Mo.

On July 16, 1926, the complainants filed with the Secretary of Agriculture a complaint seeking reparation in the sum of $300,000 on behalf of 257 individual traders who have reweighed livestock in the so-called commission division of the Kansas City Stock Yards. Complaint alleged that reweigh charges collected by the defendant company were unjust, unreasonable, and discriminatory. By his order of July 24, 1926, the Acting Secretary served said complaint on the defendant, in accordance with the provisions of the packers and stockyards act. The case is now pending.

Docket No. 167. John Noll, National Stock Yards, Ill.

On July 26, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a dealer operating on the National Stock Yards, Ill., and that respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his

obligations incurred as a dealer, contrary to and in violation of the provisions of the packers and stockyards act.

Hearing was held on September 10, 1926, and on October 14, 1926, a cease and desist order was issued.

Docket No. 168. Joe Boehm, National Stock Yards, Ill.

On July 26, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a dealer operating on the National Stock Yards, Ill., and that respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his obligations incurred as a dealer, contrary to and in violation of the provisions of the packers and stockyards act.

Hearing was held on September 10, 1926, and on October 14, 1926, a cease and desist order was issued.

Docket No. 169. D. J. Hannigan, National Stock Yards, Ill.

On July 26, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a market agency and dealer operating on the National Stock Yards, Ill., and that respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his obligations incurred as a market agency and dealer, contrary to and in violation of the provisions of the packers and stockyards act.

Hearing was held on September 19, 1926, and on October 14, 1926, a cease and desist order was issued.

Docket No. 170. Max Baum, National Stock Yards, Ill.

On July 24, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a market agency operating on the National Stock Yards, Ill., and that the respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his obligations incurred as a market agency, contrary to and in violation of the provisions of the packers and stockyards act.

A hearing was held on September 10, 1926, and on October 14, 1926, a cease and desist order was issued.

Docket No. 171. S. P. Daniels and W. W. Dunham, trading and doing business as Dunham & Daniels, National Stock Yards, Ill.

On July 26, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondents were a market agency and dealer operating on the National Stock Yards, Ill., and that the respondents had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of their obligations incurred as a market agency and dealer, contrary to and in violation of the provisions of the packers and stockyards act.

A hearing was held on September 10, 1926, and on October 14, 1926, a cease and desist order was issued.

Docket No. 172. Bernard Grewe, National Stock Yards, Ill.

On July 26, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a market agency and dealer operating on the National Stock Yards, Ill., and that the respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his obligations incurred as a market agency and dealer, contrary to and in violation of the provisions of the packers and stockyards act.

A hearing was held on September 10, 1926, and on October 14, 1926, a cease and desist order was issued, and respondent was suspended from registration for a period of two months. The respondent, having furnished a bond in the sum required by the act and regulations, and having filed a fully executed duplicate thereof with the Packers and Stockyards Administration, and having applied for a revocation of the suspension, the Acting Secretary by his order of November 9, 1926, revoked the order of suspension, effective November 10, 1926, in so far as it applied to the respondent as a market agency.

Docket No. 173. E. Parish and M. Parish, trading and doing business as E. Parish & Son, National Stock Yards, Ill.

On July 26, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondents were dealers operating on the National Stock Yards, Ill., and that the respondents had failed, neglected and refused,

and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of their obligations incurred as dealers, contrary to and in violation of the provisions of the packers and stockyards act.

A hearing was held on September 10, 1926, and on October 14, 1926, a cease and desist order was issued and respondents were suspended from registration as dealers for a period of two months.

Docket No. 174. Frank Menke and Jas. E. Rice, trading and doing business as Menke & Rice, National Stock Yards, Ill.

On July 26, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondents were dealers operating on the National Stock Yards, Ill., and that respondents had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of their obligations incurred as dealers, contrary to and in violation of the provisions of the packers and stockyards act.

A hearing was held on September 10, 1926, and on October 14, 1926, a cease and desist order was issued, and the respondents were suspended from registration as dealers for a period of two months.

Docket No. 175. T. J. Murphy *v* Union Stock Yard & Transit Co., Chicago, Ill.

On August 2, 1926, T. J. Murphy filed complaint against the Union Stock Yard & Transit Co. for reparation for the value of certain hogs lost while in the pens of the respondent company.

Hearing was held on October 6, 1926. The hearing was continued until October 26, 1926, and later the date of hearing was postponed indefinitely.

On December 10, 1926, on motion of the complainant, the Acting Secretary dismissed the complaint.

Docket No. 176. H. T. Herrell, Belt Railroad & Stock Yards Co., Indianapolis, Ind.

On July 28, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a dealer operating on the Belt Railroad & Stock Yards, Indianapolis, Ind., and that the respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his obligations incurred as a dealer, contrary to and in violation of the provisions of the packers and stockyards act.

Under date of August 7, 1926, respondent admitted the truth of the facts and allegations stated in the inquiry and notice, and on August 23, 1926, a cease and desist order was issued.

Docket No. 177. P. R. Atchison, St. Paul Union Stockyards, South St. Paul, Minn.

On September 22, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent had violated the packers and stockyards act by demanding and charging greater and different compensations for stockyard services rendered by him as a market agency than the rates and charges specified by his schedule filed and in effect.

A hearing was held on February 4, 1927. By his order of May 12, 1927, the Acting Secretary found that the respondent had made overcharges, as alleged in paragraphs 1, 2, 3, and 4 of the inquiry, and a cease and desist order was issued.

Docket No. 178. J. C. Kincaid, F. B. Brown, W. G. Stehlin, and M. B. Dunn, trading and doing business as M. B. Dunn & Co., Belt Railroad & Stock Yards, Indianapolis, Ind.

On August 3, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondents were a market agency and dealer engaged in the business of financing traders and operating at the Belt Railroad & Stock Yards, Indianapolis, Ind., and that while so engaged as market agency and dealer in the business aforesaid, respondents had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of their obligations incurred as market agency and dealer contrary to and in violation of the provisions of the packers and stockyards act.

Under date of August 30, 1926, respondents admitted the truth of the facts and allegations stated in the inquiry and waived oral hearing thereon. A cease and desist order was issued September 9, 1926.

Docket No. 179. Frank H. Lacy, Belt Railroad & Stock Yards, Indianapolis, Ind.

On August 3, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a market agency operating at the Belt Railroad & Stock Yards, Indianapolis, Ind., and that the respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute and maintain or cause to be executed and maintained a reasonable bond to secure the performance of his obligations incurred as a market agency, contrary to and in violation of the provisions of the packers and stockyards act.

Under date of August 14, 1926, respondent admitted the truth of the facts and allegations stated in the inquiry and waived an oral hearing. On August 26, 1926, a cease and desist order was issued.

Docket No. 181. Hugh Middlesworth, William C. Middlesworth, and Logan Dillon, trading and doing business as the Middlesworth Commission Co., Belt Railroad and Stock Yards, Indianapolis, Ind.

Under date of October 2, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondents while operating as a market agency on the Belt Railroad and Stock Yards, Indianapolis, Ind., had failed, neglected, and refused to execute and maintain a reasonable bond to secure their obligations.

On October 13, 1926, the respondents admitted the allegation and waived hearing.

On October 31, 1926, Logan Dillon advised the department that he had not been connected with the respondent company since July 31, 1926.

On November 12, 1926, the Acting Secretary ordered that Hugh Middlesworth and William C. Middlesworth, trading and doing business as the Middlesworth Commission Co., cease and desist from doing business without executing and maintaining a bond as required by the act.

It was further ordered that Hugh Middlesworth and William C. Middlesworth, trading and doing business as the Middlesworth Commission Co., be suspended from registration for a period of six months.

Proceedings against Logan Dillon were dismissed.

Docket No. 183. Joe Hoffman, trading and doing business as the Independent Packing Co., Union Stockyards, South Omaha, Nebr.

On October 14, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a dealer within the meaning of the packers and stockyards act, operating on the Union Stockyards, South Omaha, Nebr., and that the respondent had failed, neglected, and refused, and continued to fail, neglect, and refuse to execute or maintain, or cause to be executed or maintained a reasonable bond to secure the performance of his obligations incurred as a dealer, contrary to and in violation of the provisions of the act as amended.

On further investigation it appeared that the respondent is not engaged in business either at the stockyards, South Omaha, Nebr., or at any other stockyards under the jurisdiction of the Secretary, and that respondent does not contemplate resuming business at any stockyards under jurisdiction.

On January 24, 1927, the Acting Secretary ordered that the case be dismissed without prejudice.

Docket No. 184. Henry Nangle, Kansas City Stock Yards, Kansas City, Mo.

On November 3, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent while operating as a market agency on the Kansas City Stock Yards had failed, neglected, and refused to execute and maintain a reasonable bond to secure the performance of his obligations.

Complaint further alleged that the respondent violated the act by charging and demanding a greater or less or different compensation for stockyards services than the rates and charges specified in his schedule, and by engaging in unfair, unjustly discriminatory, and deceptive practices and devices by making false representations to his principal as to the price and weights of livestock purchased for him.

Complaint further alleged that the respondent had failed to keep adequate records.

Hearing was held on November 22, 1926.

On February 4, 1927, the Acting Secretary issued findings to the effect that the allegations as contained in the complaint were substantially true, and a cease and desist order was issued.

It was further ordered that the respondent be suspended from registration for a period of six months and that if respondent should again engage in business as a market agency at any posted stockyards subsequent to the expiration of the suspension that he

should keep adequate records disclosing his transactions.

Docket No. 185. Sunlight Produce Company, Sioux City, Iowa, and Cudahy Packing Co., Chicago, Ill.

On November 9, 1926, the Acting Secretary issued a complaint and notice alleging that the respondents had violated and were violating the packers and stockyards act by engaging in and using in commerce the unfair, unjustly discriminatory practice and device of attempting to injure and destroy the business of a competitor by false representations respecting such business, by inducing employees of such competitor to violate their contracts with said competitor, by conspiring, combining, and agreeing with employees of said competitor, to defame and falsely to represent the business of said competitor, by so conspiring to appropriate and take from said competitor, business then and there accruing to it and enjoyed by said competitor, and by employing the agent of such competitor with intent thereby to take from said competitor a substantial part of its business.

By order of December 18, 1926, proceedings against the Cudahy Packing Co. as a party were dismissed.

Hearing was held on February 1, 1927, and on June 15, 1927, by order of the Acting Secretary the complaint was dismissed without prejudice.

Docket No. 186. L. D. Himmelberger, Union Stock Yards, Lancaster, Pa.

On November 19, 1926, the Acting Secretary issued an inquiry and notice alleging that the respondent was a dealer operating at the Union Stock Yards, Lancaster, Pa., and that while so engaged as a dealer the respondent did fail, neglect and refuse, and continued to fail, neglect, and refuse to execute and maintain, or cause to be executed and maintained, a reasonable bond to secure the performance of his obligations incurred as a dealer, contrary to and in violation of the provisions of the packers and stockyards act of 1921, as amended.

Hearing was held on December 7, 1926, and on December 18, 1926, the Acting Secretary by his order suspended respondent from registration as a dealer for a period of six months, with leave to apply for revocation of said suspension upon a satisfactory showing to the Secretary that he had executed, maintained, and filed a copy of a bond as required by the act.

Respondent having furnished a satisfactory bond, the order of suspension was revoked, effective February 24, 1927, by order of the Acting Secretary, issued February 26, 1927.

Docket No. 187. Peoria Union Stock Yards Co., Peoria, Ill.

Peoria Union Stock Yards Co., having made and published, effective December 6, 1926, its Tariff No. 3, which was filed with the Secretary November 26, 1926, said tariff providing for rates and charges in excess of those previously in effect, and the Secretary having reason to believe that the rates and charges provided for by said Tariff No. 3 were unjust, unreasonable, and discriminatory, the Acting Secretary issued an inquiry and notice and an order suspending said tariff on December 3, 1926. The respondent company voluntarily withdrew said Tariff No. 3, and published a new tariff effective January 1, 1927, which was filed in accordance with the act.

The Acting Secretary dismissed the case without prejudice by his order of January 11, 1927.

Docket No. 188. A. U. Tjaden and W. F. Wells, trading and doing business as Tjaden & Wells, Sioux Falls, S. Dak.

On January 19, 1927, the Acting Secretary issued an inquiry and notice alleging that the respondents had violated, and were violating the provisions of the packers and stockyards act of 1921, in that through collusion with one George F. Coller and Trigg Angell, the respondents charged the Jacob Dold Packing Co. a greater price for certain hogs purchased for said packing company by altering scale tickets to increase the weight as shown on said scale tickets.

A hearing was held on January 29, 1927, and on May 19, 1927, a cease and desist order was issued, and the respondent Tjaden was suspended from registration for a period of 60 days, and the respondent Wells was suspended from doing business for a period of one year.

Docket No. 189. Dunning & Stevens (Inc.) et al., Buffalo Stock Yards, Buffalo, N. Y.

On March 1, 1927, the Secretary issued an inquiry and notice alleging that the respondent had engaged in and used certain unfair, unjustly, discriminatory, and deceptive practices and devices in that at various times they had received and accepted for sale on commission, consignments of livestock under a custom and implied agreement to show such livestock to all prospective bidders and sell the same at the highest bid, and at divers

times respondents had failed, neglected, and refused either to show such livestock to prospective bidders or to sell the same at the highest bid.

It was further alleged that in carrying out the aforesaid practices, respondents had engaged in the further unfair, unjustly discriminatory, and deceptive practice or device of receiving and accepting for sale on commission, livestock consigned to them, and had purported to sell such livestock under a method or practice commonly known and referred to as weighing up, and had charged a commission for making said purported sale; that the respondents had acted in the dual capacity as agent for the shipper and for the ultimate purchaser thereof, and received a double commission, and had engaged in the further deceptive practice or device of making false and misleading reports either to their consignors or to their buyer principals as to the prices, weights of livestock, or names of the actual buyers or sellers.

A hearing was held beginning March 10, 1927, and adjourned on March 15, 1927, to allow further investigation of records of respondents to be made.

On April 20, 1927, respondents, through their counsel, by stipulation in the record, admitted the material allegations in the notice of inquiry, but did not admit any conclusions of law to be drawn therefrom and waived further hearing.

On the basis of the record, on May 16, 1927, the Secretary issued findings of fact and conclusions and issued an order as follows:

FINDINGS OF FACT AND CONCLUSIONS

Upon the foregoing the Secretary finds and concludes that:

The matters and things set forth in the notice and inquiry are true.

The books and records of the respondents have fully and correctly disclosed all facts material to the transactions.

No rules or regulations of the Secretary have been promulgated or no findings have been made by him in any proceedings heretofore instituted with regard to the lawfulness of certain of the practices alleged in the notice and inquiry, such as the practices, so-called, of "weighing up," filling orders from consignments, and charging, demanding, and collecting two commissions while acting in the dual capacity of agent for both the shipper or owner and the ultimate purchaser of livestock.

The Secretary by regulation has required that market agencies, in accounting for the sale of livestock consigned to them for sale on commission, shall report to the owner or consignor the facts, including the true name of the purchaser. The respondents, pursuant to this regulation, where they "weighed up" the livestock from consignments sent to them for sale on commission, have reported this fact to the consignor.

In view of all the circumstances, and looking to the betterment of marketing conditions and the establishment and maintenance of open, competitive markets, the Secretary is not disposed to impose penalties but rather to seek remedial and corrective measures. It is deemed imperative that public-stockyards markets subject to the provisions of the packers and stockyards act shall in every sense be open, competitive market places.

After full consideration of all the facts, the practices referred to in the inquiry are found unjustly discriminatory.

ORDER

It is therefore ordered, (1) That each market agency respondent herein shall cease and desist from failing or refusing, in an unjustly discriminatory manner, to permit bona fide bidders in the usual and regular course of business to look at and bid on livestock consigned to the respondent market agencies for sale on commission, and from failing or refusing to accept the best bid which it is possible to obtain in the usual and regular course of business, and in accordance with the established customs of the markets; and (2) that each market agency respondent herein shall cease and desist from the practice of purporting to buy or take title to livestock consigned to it for sale on a commission basis by the use of a method known as "weighing up," and shall cease and desist from acting in the dual capacity of agent for the shipper and the ultimate purchaser with respect to the same livestock.

No order is made with respect to making false and misleading reports incident to and solely dependent upon the use of the aforesaid method and practices, as the discontinuance of such method and practices will eliminate such reports.

It is further ordered, That a copy hereof be served on each of the respondents by registered mail, and that this order shall be effective on and after May 16, 1927.

Docket No. 190. George W. Waitt and Frank Lake, trading and doing business as Waitt & Lake Commission Co., Sioux City Stock Yards, Sioux City, Iowa

On March 16, 1927, the Acting Secretary issued an inquiry and notice alleging that respondents had violated the provisions of the packers and stockyards act by charging and demanding greater or less and different compensations for stockyard services rendered by them as a market agency than the rates and charges specified in their schedule filed and in effect.

Under date of April 23, 1927, the respondents admitted the allegations in the complaint and waived a hearing thereon. On May 14, 1927, a cease and desist order was issued.

Docket No. 191. Union Stock Yards, San Antonio, Tex.

Respondent company having made and published its local tariff No. 4, effective November 17, 1926, which tariff contained among others a rate or charge applicable to cattle, calves, hogs, sheep, and goats resold, and complaint having been made by various

market agencies and dealers operating on said stockyards, the Acting Secretary on April 19, 1927, issued an order for an investigation and hearing on the complaint.

Hearing was held beginning May 2, 1927. This case is now pending.

Docket No. 192. Jack Lee Live Stock Commission Co., Union Stock Yards, Ogden, Utah.

On April 15, 1927, the Acting Secretary issued an inquiry and notice alleging respondent, operating as a market agency and dealer at the Union Stock Yards, Ogden, Utah, to be insolvent.

Hearing was held on May 14, 1927. The case is now pending.

Docket No. 193. Southwest Commission Co., Los Angeles, Calif.

On March 2, 1927, H. P. Prescott, of Rodeo, N. Mex., filed with the Secretary a complaint and a request for an inquiry and investigation and full reparation against the defendant. Copy of this complaint was forwarded to the defendant, who was called upon to satisfy said complaint or answer it in writing. Defendant elected to answer. It appearing that there was reasonable ground for an investigation, the Acting Secretary on April 20, 1927, issued a notice of inquiry and hearing on said complaint.

Hearing was held May 10, 1927. The case is now pending.

Docket No. 194. Producers Cooperative Commission Association, Buffalo Stock Yards, Buffalo, N. Y.

On April 28, 1927, the Secretary issued an inquiry and notice alleging that the respondents had engaged in and used certain unfair, unjustly discriminatory, and deceptive practices and devices in that at various times they had received and accepted for sale on commission, consignments of livestock under a custom and implied agreement to show such livestock to all prospective bidders and sell the same at the highest bid, and at divers times respondents had failed, neglected, and refused either to show such livestock to prospective bidders or to sell the same at the highest bid.

It was further alleged that in carrying out the aforesaid practices respondents had engaged in the further unfair, unjustly discriminatory, and deceptive practice or device of receiving and accepting for sale on commission, livestock consigned to them, and had purported to sell such livestock under a method or practice commonly known and referred to as weighing up, and had charged a commission for making said purported sale; that the respondents had acted in the dual capacity as agent for the shipper and for the ultimate purchaser thereof, and received a double commission, and had engaged in the further deceptive practice or device of making false and misleading reports either to their consignors or to their buyer principals as to the prices, weights of livestock, or names of the actual buyers or sellers.

The case is now pending.

Docket No. 195. H. J. Hunt, D. J. Russell and V. B. Quiggins, trading and doing business as Hunt, Russell & Co., Louisville Stockyards, Louisville, Ky.

On May 12, 1927, the Acting Secretary issued an inquiry and notice alleging that respondent had violated the provisions of the packers and stockyards act by charging and demanding greater or less and different compensations for stockyard services rendered by it as a market agency than the rates and charges specified in its schedule filed and in effect.

The case is now pending.

Docket No. 196. Dallas Smythe, St. Joseph Stock Yards, South St. Joseph, Mo.

On June 1, 1927, the Acting Secretary issued an inquiry and notice alleging that respondent had violated the provisions of the packers and stockyards act by engaging in the unfair and deceptive practice and device of posting in the South St. Joseph Stock Yards a false and fictitious bulletin purporting to show the arrival of livestock at the South St. Joseph Stock Yards. Complaint further alleged that said bulletin purported to show the arrival of certain hogs and would, in the ordinary course of business on said stock yards, be taken to be a bulletin posted by said Stock Yards Co. and based upon waybill received by said company from the carrier, whereas in fact said hogs did not arrive at the time and in the manner stated in said bulletin.

The case is now pending.

Docket No. 197. Jack Lee Livestock Commission Co., Ogden Stockyards, Oregon, Utah.

On June 22, 1927, the Acting Secretary ordered an investigation to determine whether or not the respondent had violated the provisions of the packers and stockyards act, 1921, by engaging in and using certain unfair, unjustly discriminatory, and deceptive practices and devices in connection with the rendering of "stockyards services" as a market agency. The Secretary also alleged that the re-

spondent violated his tariff by charging, demanding, collecting, and receiving a greater or less or different compensation for stockyards services than the rates and charges specified in the schedule on file and in effect at the time of making such charges. Notice of the above was served on the respondent, stating that if he did not either satisfactorily explain or admit the above allegations, the matter would be set down for a hearing. The respondent has answered some of the charges, and the matter is now pending.

SCHEDULES OF STOCKYARD COMPANIES

Table 7 shows the rates and charges for yardage and feed at a number of the leading markets. These were the charges in effect on June 30, 1927. There are many charges for incidental services provided for in the schedules which are not given in this table. There are also differences in the types of feed fed at the different markets. In most cases there are several kinds of hay used, and the price is given for that kind which is most generally used at the market.

TABLE 7.—*Stockyard charges for yardage and feed as of June 30, 1927, as shown by tariffs on file with the Secretary of Agriculture*

Stockyards and address	Yardage per head								Feed		
	Cattle		Calves		Hogs		Sheep		Hay per hundredweight	Corn per bushel	Oats per bushel
	A[1]	B[2]	A	B	A	B	A	B			
	Cts.	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Dollars*	*Dollars*	*Dollars*
Atlanta Union Stockyards, Atlanta, Ga	30	-----	15	-----	10	-----	10	-----	1.75	1.75	-----
Union Stockyards, Baltimore, Md	40	-----	20	-----	10	-----	8	-----	2.00	1.75	1.00
Buffalo Stockyards, Buffalo, N. Y	30	50	25	35	12	22	8	14	1.80	1.65	1.25
Union Stockyards, Chicago, Ill	35	40	25	27	12	14	8	10	1.90	1.55	1.00
Union Stockyards, Cincinnati, Ohio	30	35	15	20	10	12	8	10	1.75	1.50	1.00
Union Stockyards, Cleveland, Ohio	33	40	25	30	12	16	8	12	1.90	1.75	-----
Union Stockyards, Denver, Colo	35	40	25	27	12	14	8	10	1.50	1.50	-----
Detroit Stockyards, Detroit, Mich	30	50	25	35	12	22	8	14	1.80	1.65	1.25
Union Stockyards, Evansville, Ind	35	40	15	20	11	13	10	12	1.75	1.40	1.00
Union Stockyards, Fort Wayne, Ind	30	37	15	19	10	14	10	12	1.75	1.10	-----
Fort Worth Stockyards, Fort Worth, Tex	35	-----	25	-----	12	-----	8	-----	1.50	1.55	1.00
Belt Railroad & Stockyards Co., Indianapolis, Ind	30	35	15	20	10	12	8	10	1.90	1.45	1.00
Jersey City Stockyards, Jersey City, N. J	40	50	20	25	12	15	8	10	2.00	2.00	1.40
Kansas City Stockyards, Kansas City, Mo	35	-----	25	-----	12	-----	8	-----	1.37½	1.45	-----
Union Stockyards, La Fayette, Ind	30	40	15	25	10	15	10	10	1.80	1.25	-----
Union Stockyards, Lancaster, Pa	15	-----	10	-----	8	-----	5	-----	1.75	1.75	1.00
Union Stockyards, Laredo, Tex	35	-----	25	-----	12	-----	8	-----	1.50	-----	1.00
Union Stockyards, Los Angeles, Calif	35	40	25	27	12	14	8	10	1.80	1.80	-----
Bourbon Stockyards, Louisville, Ky	35	40	16	20	11	13	9	11	2.00	1.60	1.00
Dixie National Stockyards, Memphis, Tenn	35	-----	20	-----	10	-----	10	-----	[3] 1.50	1.50	-----
Milwaukee Stockyards, Milwaukee, Wis	25	-----	15	-----	8	-----	5	-----	1.50	1.30	1.00
Union Stockyards, Montgomery, Ala	35	40	20	25	12	14	12	14	1.85	1.75	-----
Union Stockyards, Nashville, Tenn	35	40	20	25	12	14	10	12	[3] 2.25	1.75	-----
National Stockyards, National Stock Yards, Ill	35	-----	25	-----	12	-----	8	-----	1.90	1.45	1.00
Newark Stockyards, Kearny, N. J	27½	40	10	15	6	8	4½	7	1.75	1.55	-----
Union Stockyards, New York, N. Y	40	50	20	25	12	25	8	10	2.00	1.75	1.25
Union Stockyards, Ogden, Utah	30	-----	20	-----	10	-----	5	-----	1.40	[4] 3.00	-----
Oklahoma National Stockyards, Oklahoma City, Okla	35	40	25	27	12	14	8	10	1.50	1.50	.90
Union Stockyards, Omaha, Nebr	35	40	25	27	12	14	8	10	-----	1.45	-----
Union Stockyards, Pasco, Wash	25	-----	15	-----	10	-----	5	-----	1.50	[4] 3.00	-----
Union Stockyards, Peroria, Ill	22	27	11	15	9	11	6	8	1.70	1.30	.70
West Philadelphia Stockyards, Philadelphia, Pa	40	-----	15	-----	10	-----	7	-----	2.00	1.75	-----
Union Stockyards, Pittsburgh, Pa	33	-----	20	-----	11	-----	7	-----	1.75	1.50	1.00
Union Stockyards, North Portland, Oreg	30	-----	20	-----	10	-----	7	-----	1.75	-----	-----

[1] Received by rail.
[2] Received other than by rail.
[3] Price per bale.
[4] Price per hundredweight.

TABLE 7.—*Stockyard charges for yardage and feed as of June 30, 1927, as shown by tariffs on file with the Secretary of Agriculture*—Continued

Stockyards and address	Yardage per head								Feed		
	Cattle		Calves		Hogs		Sheep		Hay per hundredweight	Corn per bushel	Oats per bushel
	A	B	A	B	A	B	A	B			
Union Stockyards, North Salt Lake, Utah	Cts. 30	Cts. -----	Cts. 20	Cts. -----	Cts. 10	Cts. -----	Cts. 5	Cts. -----	Dollars 1.50	Dollars [4] 3.00	Dollars -----
Union Stockyards, San Antonio, Tex.	35	-----	25	-----	12	-----	8	-----	1.20	1.50	0.80
Union Stockyards, San Francisco, Calif.	35	40	25	27	12	14	8	10	1.75	[4] 3.50	-----
Union Stockyards, Seattle, Wash.	30	35	20	22	10	12	7	9	1.65	-----	-----
Sioux City Stockyards, Sioux City, Iowa	35	40	25	27	12	14	8	10	1.37½	1.45	.75
Sioux Falls Stockyards, Sioux Falls, S. Dak.	35	-----	25	-----	12	-----	8	-----	1.37½	1.30	.75
Union Stockyards, Spokane, Wash.	35	-----	25	-----	12	-----	7	-----	1.60	[4] 3.50	-----
Stockton Feed Yards, Stockton, Calif.	30	-----	20	-----	12	-----	8	-----	1.25	[4] 3.00	-----
St. Joseph Stockyards, St. Joseph, Mo.	35	40	25	27	12	14	8	10	1.37½	1.45	.90
Union Stockyards, St. Paul, Minn.	30	35	20	22	10	12	7	9	1.50	1.45	.75
Union Stockyards, Wichita, Kans.	35	40	25	27	12	14	8	10	1.37½	1.50	.75

[4] Price per hundredweight.

SCHEDULES OF MARKET AGENCIES

The following is a schedule of the commission charges for selling straight cars of livestock which were in effect at a number of the leading markets on June 30, 1927. This does not represent the complete schedule of rates and charges. In many cases the tariffs make provisions for separate charges for buying and selling mixed car lots, drive-in livestock, and plural ownership consignments of livestock. In some cases additional charges are made for extra services such as prorating, extra sorting and rendering separate accounts. The charges set forth in each instance represent those observed by most of the market agencies at each market. There are a few cases in which market agencies operate on different schedules from those customarily followed at the market.

UNION STOCKYARDS, BALTIMORE, MD.

Hogs.—Minimum, 2 per cent on gross sales.

Calves.—Minimum, 2 per cent on gross sales.

Lambs.—Minimum, 2 per cent on gross sales.

Cattle.—$1.25 per head; maximum charge, $30 per car. Western stock cattle, $25 per car. On canner cattle over 1 year old which sell for $20 or less per head, $1 per head.

BUFFALO STOCKYARDS, BUFFALO, N. Y.

Cattle.—Per head, $1, with a minimum charge of $18 and a maximum charge of $22 per carload.

Hogs.—Per single-deck carload, $14; per double-deck carload, $22.

Sheep.—Per single-deck carload, $14; per double-deck carload, $22.

Calves.—Per single-deck carload, $16; per double-deck carload, $24.

UNION STOCKYARDS, CHICAGO, ILL.

Cattle.—Twenty head or less, $17, and 75 cents per head for each additional head over 20 head, with a maximum of $21. When car contains less than 14 head, the "drive-in" schedule applies.

Calves.—Single deck, 50 head or less, $17, and 30 cents per head for each additional head over 50 head, with a maximum of $22. Double deck, 70 head or less, $23, and 30 cents per head for each additional head over 70 head, with a maximum of $28. When car contains less than 40 head, the "drive-in" schedule applies.

Hogs.—Single deck, 50 head or less, $13, and 15 cents per head for each additional head over 50 head, with a maximum of $15. An additional charge of 30 cents shall be made for each full 500 pounds weight over 17,000 pounds. Double deck, 80 head or less, $18, and 15 cents per head for each additional head over 80 head, with a maximum of $23. An additional charge of 30 cents shall be made for each full 500 pounds weight over 27,000 pounds. When a car contains less than 40 head, the "drive-in" schedule applies.

Sheep.—Single deck, $14. Double deck, $20. When a car contains less than 50 head, the "drive-in" schedule applies.

UNION STOCKYARDS, CINCINNATI, OHIO

Cattle in carload lots.—$1 per head. Maximum, $25 per car plus 50 cents per head for all calves contained therein.

Calves in cars.—50 cents per head, regardless of number (400 pounds and over to take cattle rate). Maximum for single-deck loads, $25, and for double-deck loads, $35.

Hogs in carload lots.—Single deck, $15; double deck, $25.

Sheep or lambs in carload lots.—Single deck, $15; double deck, $25. (One hundred head and above to constitute a deck.)

UNION STOCKYARDS, CLEVELAND, OHIO

Cattle.—$1 per head with a minimum charge of $18 and a maximum charge of $22 per carload.
Hogs.—Per single deck, $14; double deck, $22.
Sheep.—Per single deck, $14; double deck, $22.
Calves.—Per single deck, $15; double deck, $22.

UNION STOCKYARDS, DENVER, COLO.

Cattle.—Twenty head or less, $15, and 65 cents per head for each additional head over 20 head, with a maximum of $19. When car contains less than 14 head, the "drive-in" schedule applies.
Calves.—Single deck, 50 head or less, $15, and 30 cents per head for each additional head over 50 head, with a maximum of $20.
Calves.—Double deck, 70 head or less, $21, and 30 cents per head for each additional head over 70 head, with a maximum of $26. When car contains less than 40 head, the "drive-in" schedule applies.
Hogs.—Single deck, 50 head or less, $12, and 15 cents per head for each additional head over 50 head, with a maximum of $14. An additional charge of 30 cents shall be made for each full 500 pounds weight over 17,000 pounds.
Hogs.—Double deck, 80 head or less, $17, and 15 cents per head for each additional head over 80 head, with a maximum of $22. An additional charge of 30 cents shall be made for each full 500 pounds weights over 27,000 pounds. When a car contains less than 40 head, the "drive-in" schedule applies.
Sheep.—Single deck, $14; double deck, $20. When a car contains less than 40 head, the "drive-in" schedule applies.

DETROIT STOCKYARDS, DETROIT, MICH.

Cattle.—Per carload, $20.
Hogs.—Per double-deck carload, $20.
Hogs.—Per single-deck carload, $14.
Sheep and lambs.—Per double-deck carload, $20.
Sheep and lambs.—Per single-deck carload, $14.
Calves.—Per double-deck carload, $20.
Calves.—Per single-deck carload, $14.

FORT WORTH STOCKYARDS, FORT WORTH, TEX.

Cattle.—75 cents each; $12 minimum, $18 maximum.
Calves.—35 cents each; $12 minimum, $18 maximum; double deck, $30, maximum.
Hogs.—30 cents each; $8 minimum, $12 maximum; double deck, $20 maximum.
Sheep or goats.—20 cents each, $8 minimum, $12 maximum, double deck, $20 maximum.
Those in single decks where double-deck freight rates apply double-deck rates.

BELT RAILROAD & STOCKYARDS CO., INDIANAPOLIS, IND.

Cattle, 75 cents a head; *calves,* 35 cents a head; *hogs,* 20 cents a head; *sheep* and *goats,* 20 cents a head.
For single decks.—No minimum charge on a straight unmixed load belonging to one person or partnership. Maximum for cattle, $21; for calves, $18; for hogs, $12; for sheep or goats, $12.
For double decks.—Minimum and maximum straight loads: Calves, minimum, $20; maximum $23; hogs, no minimum; maximum, $20; sheep or goats, no minimum; maximum, $18.

KANSAS CITY STOCKYARDS, KANSAS CITY, MO.

Cattle.—Sec. 1. Single ownership, carload lots, 20 head or less $15 and 65 per cent for each additional head over 20 head, with maximum of $19. When car contains less than 14 head the "drive-in" schedule applies.
Calves.—Single deck; 50 head or less $15 and 30 cents per head for each additional head over 50 head, with a maximum of $20.
Calves.—Double deck; 70 head or less $21 and 30 cents per head for each additional head over 70, with a maximum of $26. When car contains less than 40 head, the "drive-in" schedule applies.
Hogs.—Single deck; 50 head or less $12 and 15 cents per head for each additional head over 50 head, with a maximum of $14. An additional charge of 30 cents shall be made for each full 500 pounds weight over 17,000 pounds.
Hogs.—Double deck; 80 head or less $17 and 15 cents per head for each additional head over 80 head, with a maximum of $22. An additional charge of 30 cents shall be made for each full 500 pounds weight over 27,000 pounds. When a car contains less than 40 head, the "drive-in" schedule applies.
Sheep.—Single deck, $14; double deck, $20. When a car contains less than 50 head, the "drive-in" schedule applies.

UNION STOCKYARDS, LOS ANGELES, CALIF.

Cattle.—75 cents per head; $16 per carload minimum, $21 maximum.
Calves.—35 cents per head; $16 per carload minimum, $21 maximum; double deck, 35 cents per head; $21 per carload minimum, $25 maximum.
Fifteen head cattle in car shall constitute a carload; less at "drive-in" rates.
Hogs.—30 cents per head; $12 per carload minimum, $15 maximum; double-deck cars, $24.
Sheep or goats.—25 cents each; single deck, $14; double deck, $20. Sheep or goats originating in double-deck cars, but for any reason arriving in single-deck cars, where double-deck freight rates are applied, may be sold at the double-deck rates of commission, namely, $20 per car.
Less than 30 head of hogs or sheep, in a single-deck car, with no other stock in the car, shall be charged for at "drive-in" rates.

BOURBON STOCKYARDS, LOUISVILLE, KY.

Cattle.—Sold in carloads, $1 per head, not to exceed $20 per carload.
Calves.—50 cents per head, not to exceed $20 per car.
Hogs.—In carloads 50 head or more, 8 cents per hundredweight: minimum, $10; maximum, $15 per single deck, or 8 cents per hundred weight for double deck. Any number in carloads less than 50 head, 20 cents per head.
Sheep and lambs.—In carloads less than 50 head, 20 cents per head; 50 to 100 head $10 per lot; more than 100 head, 10 cents per head.
Stock sheep.—Less than 50 head, 20 cents per head; 50 to 70 head, $10 per

lot; more than 70 head, 15 cents per head. No maximum.

UNION STOCKYARDS, NASHVILLE, TENN.

Cattle.—The commission for selling cattle shall be $1 per head, with a maximum of $20 for a straight carload of cattle. Cattle brought to the market otherwise than in railroad cars, 25 head shall constitute a carload.

Calves.—The commission for selling calves shall be 50 cents per head with a maximum of $20 for a straight single deck, and a maximum of $25 for a straight double deck of calves.

Hogs.—The commission for selling hogs shall be 25 cents per head up to 50 head; more than 50 head, 8 cents per hundredweight; minimum $12.50 per single deck, maximum $15; maximum double deck $25.

Sheep and lambs.—The commission for selling sheep, lambs, or goats shall be 20 cents per head up to 50 head. In lots of 50 to 100 head, $10 per lot. More than 100 head, 10 cents per head.

UNION STOCKYARDS, NEW YORK, N. Y.

Cattle.—The commission charge for selling all cattle, except yearlings, amounting to $20 or less per head shall be 75 cents per head. The charge for all cattle selling for amounts over $20 per head shall be $1.25 per head.

Calves and yearlings.—The commission for selling calves and yearlings weighing less than 350 pounds shall be 30 cents per head. Calves and yearlings weighing 350 pounds and over, 60 cents per head. Provided that no straight load of southern or western calves shall be sold for less than a minimum charge of $25, actual figures to apply when commission charges on basis of above "per head" rate shall be in excess of $25 for the load. These charges to apply on all calves and yearlings with the exception of calves off the Harlem Division of the New York Central Railroad, which are sold and weighed in lots of one or two at the Sixtieth Street Stockyards and which are usually charged for on basis of 40 cents per head.

Sheep and lambs.—The commission for selling sheep and lambs shall be 15 cents per head.

Hogs.—The commission for selling hogs shall be 2 per cent gross.

OKLAHOMA NATIONAL STOCKYARDS, OKLAHOMA CITY, OKLA.

Cattle.—80 cents each; $17 minimum, $22 maximum.

Calves.—40 cents each; $17 minimum; $22 maximum; double deck cars, $25 maximum.

Hogs.—30 cents each; $12 minimum; $15 maximum; double deck, $24 maximum.

Sheep or goats.—25 cents each; $12 minimum; $15 maximum; double deck, $24 maximum.

Those in single deck where double-deck freight rates apply double-deck rates.

UNION STOCKYARDS, OMAHA, NEBR.

Cattle.—Twenty head or less, $16, and 75 cents per head for each additional head over 20 head, with a maximum of $21. When car contains less than 14 head, the "drive-in" schedule applies.

Calves.—Single deck, 50 head or less, $16, and 35 cents per head for each additional head over 50 head, with a maximum of $21; double deck, 70 head or less, $21, and 35 cents per head for each additional head over 70 head, with a maximum of $27. When car contains less than 40 head, the "drive-in" schedule applies.

Hogs.—Single deck, 50 head or less, $12, and 25 cents per head for each additional head over 50 head, with a maximum of $14. An additional charge of 30 cents shall be made for each full 500 pounds weight over 16,500 pounds; double deck, 80 head or less, $17, and 25 cents per head for each additional head over 80 head, with a maximum of $22. An additional charge of 30 cents shall be made for each full 500 pounds weight over 24,000 pounds. When a car contains less than 40 head, the "drive-in" schedule applies.

Sheep.—Single deck, $14; double deck, $20. When a car contains less than 40 head, the "drive-in" schedule applies.

UNION STOCK YARDS, PEORIA, ILL.

Cattle.—Twenty head or less, $17, and 75 cents per head for each additional head over 20 head, with a maximum of $21. When car contains less than 14 head, the "drive-in" schedule applies.

Calves.—Single deck, 50 head or less, $17.50, and 30 cents per head for each additional head over 50 head, with a maximum of $22; double deck, 70 head or less, $23, and 30 cents per head for each additional head over 70 head, with a maximum of $28. When car contains less than 40 head, the "drive-in" schedule applies.

Hogs.—Single deck, 50 head or less, $13, and 15 cents per head for each additional head over 50 head, with a maximum of $15. An additional charge of 30 cents shall be made for each full 500 pounds weight over 17,000 pounds. Double deck, 80 head or less, $18, and 15 cents per head for each additional head over 80 head, with a maximum of $23. An additional charge of 30 cents shall be made for each full 500 pounds weight over 27,000 pounds. When a car contains less than 40 head, the "drive-in" schedule applies.

Sheep.—Single deck, $14; double deck, $20. When a car contains less than 50 head, the "drive-in" schedule applies.

UNION STOCK YARDS, PITTSBURGH, PA.

Cattle.—1.25 per head; maximum per car, $25.

Hogs.—$15 per single deck; $25 per double deck.

Sheep.—$15 per single deck; $25 per double deck.

Calves.—$18 per single deck; $28 per double deck.

UNION STOCK YARDS, NORTH PORTLAND, OREG.

Cattle.—75 cents per head; minimum, $15; maximum, $18.75.

Calves.—40 cents per head; minimum, $15; maximum, $18.75. Double deck, 40 cents per head; minimum, $20; maximum, $25.

Hogs.—25 cents per head. Single-deck cars, minimum, $10; maximum, $12.50. Double-deck cars, minimum, $15; maximum, $18.75.

Sheep or goats.—Single-deck cars, $12.50; double-deck cars, $18.75. Sheep originating in double-deck cars but for any reason arriving in single-deck cars where double-deck freight rates are applied may be sold at the double-deck rate of commission, viz, $18.75.

SIOUX CITY STOCK YARDS, SIOUX CITY, IOWA

Cattle.—Twenty head or less, $16, and 75 cents per head for each additional head over 20 with a maximum of $21. When car contains less than 14 head "drive-in" schedule applies.

Calves.—Single-deck, 50 head or less, $16, and 35 cents per head for each additional head over 50 head, with a maximum of $21; double deck, 70 head or less, $21 and 35 cents per head for each additional head over 70 with a maximum of $27. When car contains less than 40 head "drive-in" schedule applies.

Hogs.—Single-deck, 50 head or less, $12, and 25 cents per head for each additional head over 50, with a maximum of $14. An additional charge of 30 cents for each full 500 pounds weight over 16,500. Double deck, 80 head or less, $17, and 25 cents per head for each additional head over 80, with a maximum of $22. An additional charge of 30 cents shall be made for each full 500 pounds weight in excess of 24,000 pounds. When car contains less than 40 head, the "drive-in" schedule applies.

Sheep.—Single deck, $14; double deck, $20. When the car contains less than 50 head the "drive-in" schedule applies.

ST. JOSEPH STOCK YARDS, SOUTH ST. JOSEPH, MO.

Cattle.—Twenty head or less, $15 and 65 cents per head for each additional head over 20 head, with a maximum of $19. When car contains less than 14 head, the "drive-in" schedule applies.

Calves.—Single deck, 50 head or less, $15, and 30 cents per head for each additional head over 50 head, with a maximum of $20; double deck, 70 head or less, $21, and 30 cents per head for each additional head over 70 head, with a maximum of $26. When a car contains less than 40 head, the "drive-in" schedule applies.

Hogs.—Single deck, 50 head or less, $12, and 15 cents per head for each additional head over 50 head, with a maximum of $14. An additional charge of 30 cents shall be made for each full 500 pounds weight over 17,000 pounds. Double deck, 80 head or less, $17, and 15 cents per head for each additional head over 80 head, with a maximum of $22. An additional charge of 30 cents shall be made for each full 500 pounds weight over 27,000 pounds. When a car contains less than 40 head, the "drive-in" schedule applies.

Sheep.—Single deck, $14; double deck, $20. When a car contains less than 50 head the "drive-in" schedules applies.

NATIONAL STOCKYARDS, NATIONAL STOCK YARDS, ILL.

Cattle.—Twenty head or less, $17 and 75 cents per head for each additional head over 20 head, with a maximum of $21. When car contains less than 14 head, the "drive-in" schedule applies.

Calves.—Single deck, 50 head or less, $17 and 30 cents per head for each additional head over 50 head, with a maximum of $22; double deck, 70 head or less, $23 and 30 cents per head for each additional head over 70 head, with a maximum of $28. When car contains less than 40 head, the "drive-in" schedule applies.

Hogs.—Single deck, 50 head or less, $13, and 15 cents per head for each additional head over 50 head, with a maximum of $15. An additional charge of 30 cents shall be made for each full 500 pounds weight over 17,000 pounds. Double deck, 80 head or less, $18, and 15 cents per head for each additional head over 80 head, with a maximum of $23. An additional charge of 30 cents shall be made for each full 500 pounds weight over 27,000 pounds. When a car contains less than 40 head, the "drive-in" schedule applies.

Sheep.—Single deck, $14; double deck, $20. When a car contains less than 50 head, the "drive-in" schedule applies.

UNION STOCKYARDS, SOUTH ST. PAUL, MINN.

Cattle.—Twenty head or less, $15, and 65 cents per head for each additional head over 20 head, with a maximum of $19. When car contains less than 14 head, the "drive-in" schedule applies.

Calves.—Single deck, 50 head or less, $15, and 30 cents per head for each additional head over 50 head, with a maximum of $20; double deck, 70 head or less, $21, and 30 cents per head for each additional head over 70 head, with a minimum of $26. When car contains less than 40 head, the "drive-in" schedule applies.

Hogs.—Single deck, 50 head or less, $12, and 15 cents per head for each additional head over 50 head, with a maximum of $14. An additional charge of 30 cents will be made for each full 500 pounds weight over 17,000 pounds. Double deck, 80 head or less, $17, and 15 cents per head for each additional head over 80 head, with a maximum of $22. An additional charge of 30 cents will be made for each full 500 pounds weight over 27,000 pounds. When car contains less than 40 head, the "drive-in" schedule applies.

Sheep.—Twenty cents per head; single deck, $14; double deck, $20. When a car contains less than 70 head, the "drive-in" schedule applies.

UNION STOCKYARDS, WICHITA, KANSAS

Cattle.—75 cents each; $20 maximum.

Calves.—35 cents each; $20 maximum; double decks, 35 cents each; $25 maximum.

Hogs.—25 cents each: $14 maximum; double decks, 25 cents each; $20 maximum.

Sheep or goats.—25 cents each; $14 maximum; double decks, 25 cents each; $18 maximum.

Those coming in single decks where double-deck freight rates apply, double-deck rates.

TABLE 8.—*Number of livestock received at 66 markets, as reported by the Bureau of Agricultural Economics*

Market	Year	Cattle	Calves	Hogs	Sheep	Total number of animals
Arabi, La. (New Orleans stockyards)	1922	81,786	110,975	40,984	4,246	237,991
	1923	83,105	123,596	46,456	3,861	257,018
	1924	76,994	134,812	49,602	2,299	263,707
	1925	87,655	116,839	30,272	2,490	237,256
	1926	81,377	120,464	32,889	2,099	236,829
Albany, N. Y.	1922	7,707	12,797	424	21	20,949
	1923	6,406	7,650	440	----------	14,496
	1924	7,847	5,334	214	----------	13,395
	1925	6,937	3,117	61	----------	10,115
	1926	8,858	1,934	126	----------	10,918
Amarillo, Tex.	1922	140,252	128	106,261	72,871	319,512
	1923	115,153	159	65,204	101,105	281,621
	1924	129,926	251	20,831	159,375	310,383
	1925	[1] 163,171	----------	20,425	148,020	331,616
	1926	[1] 119,830	----------	10,205	94,881	224,916
Atlanta, Ga.	1922	29,110	955	123,823	2,345	156,233
	1923	55,215	3,547	200,801	4,679	264,242
	1924	44,436	5,937	158,628	2,612	211,613
	1925	47,965	7,243	124,416	6,247	185,871
	1926	43,291	12,784	139,928	2,443	198,446
Augusta, Ga.	1922	10,121	3,680	11,399	63	25,263
	1923	8,788	3,580	10,886	38	23,292
	1924	6,397	2,815	7,284	149	16,645
	1925	6,762	2,496	3,965	78	13,301
	1926	5,703	3,755	2,943	5	12,406
Baltimore, Md.	1922	168,250	72,892	1,342,595	306,336	1,890,073
	1923	161,185	67,018	1,547,235	283,967	2,059,405
	1924	163,526	69,387	1,512,888	288,060	2,033,861
	1925	163,167	83,431	1,006,944	306,635	1,560,177
	1926	157,366	89,937	947,783	291,908	1,486,994
Boston, Mass. (Brighton)	1922	44,268	32,318	8,233	1,800	86,619
	1923	42,546	24,666	5,310	3,663	76,185
	1924	46,716	54,025	8,194	1,503	110,438
	1925	51,702	74,836	11,282	2,841	140,661
	1926	44,630	63,682	12,138	3,196	123,646
Buffalo, N. Y.	1922	315,445	321,904	1,474,520	1,190,564	3,302,433
	1923	297,024	291,483	1,831,063	1,226,440	3,646,010
	1924	275,613	274,473	1,656,469	1,165,934	3,372,489
	1925	291,289	307,899	1,130,803	1,058,708	2,788,699
	1926	296,796	297,025	968,869	1,110,812	2,673,502
Chattanooga, Tenn.	1922	19,194	----------	13,130	3,556	35,880
	1923	16,618	3	16,168	1,952	34,741
	1924	15,236	----------	19,422	1,251	35,909
	1925	14,728	----------	19,938	1,823	36,489
	1926	14,096	----------	18,670	1,403	34,169
Chicago, Ill.	1922	3,163,009	771,489	8,156,472	3,873,917	15,964,887
	1923	3,157,100	760,751	10,460,134	4,097,833	18,475,818
	1924	3,202,719	794,350	10,443,175	4,192,265	18,632,509
	1925	3,023,387	847,762	7,995,964	3,968,670	15,835,783
	1926	3,256,916	755,393	7,092,529	4,404,851	15,509,689
Cincinnati, Ohio	1922	282,742	162,812	1,347,129	394,342	2,187,025
	1923	262,070	163,568	1,400,697	345,053	2,171,388
	1924	267,957	174,312	1,365,008	327,303	2,134,580
	1925	260,245	171,518	1,040,415	369,805	1,841,983
	1926	248,901	163,915	1,047,101	329,380	1,789,297
Cleveland, Ohio	1922	136,167	145,329	1,092,287	360,432	1,734,215
	1923	129,702	148,121	1,185,211	332,714	1,795,748
	1924	134,183	150,323	1,269,360	364,822	1,918,688
	1925	132,507	160,208	784,720	415,555	1,492,990
	1926	116,617	143,136	701,176	393,063	1,353,992
Columbia, S. C.	1922	5,797	1,626	8,605	396	16,424
	1923	7,920	2,505	14,988	630	26,043
	1924	1,566	618	3,708	149	6,041
	1925	[2]	----------	----------	----------	----------
	1926	----------	----------	----------	----------	----------

[1] Calves included.

[2] Canceled.

TABLE 8.—*Number of livestock received at 66 markets, as reported by the Bureau of Agricultural Economics*—Continued

Market	Year	Cattle	Calves	Hogs	Sheep	Total number of animals
Columbus, Ohio	1922	1,670	2,105	53,371	2,120	59,266
	1923	1,194	1,863	74,119	1,572	78,748
	1924	417	676	28,855	210	30,158
	1925					
	1926					
Dallas, Tex	1922	6,815	1,440	71,279	695	80,229
	1923	5,200	1,610	110,553	256	117,619
	1924	5,653	1,648	107,623	227	115,151
	1925	9,924	2,328	53,563	204	66,019
	1926	9,929	2,296	43,582	207	56,014
Dayton, Ohio	1922	23,273	9,340	139,020	7,900	179,533
	1923	23,529	10,476	167,320	6,890	208,215
	1924	23,732	10,597	160,696	8,245	203,270
	1925	22,907	10,893	122,079	7,745	163,624
	1926	24,116	9,609	117,504	7,675	158,904
Denver, Colo	1922	586,730	69,515	395,219	1,866,784	2,918,248
	1923	561,261	58,621	495,292	1,856,578	2,971,752
	1924	571,703	58,650	569,038	2,039,660	3,239,051
	1925	526,625	60,222	467,404	2,357,010	3,411,261
	1926	472,654	56,397	497,047	1,825,922	2,852,020
Detroit, Mich	1922	128,264	124,620	444,961	356,479	1,054,324
	1923	132,434	135,822	537,447	297,767	1,103,470
	1924	129,230	153,966	555,693	393,448	1,232,337
	1925	136,750	165,797	438,569	366,505	1,107,621
	1926	134,418	171,833	427,352	392,884	1,126,487
East St. Louis, Ill	1922	1,025,763	374,570	3,605,520	627,880	5,633,733
	1923	1,040,833	358,076	4,831,181	560,678	6,790,768
	1924	1,034,446	350,180	4,579,538	488,630	6,452,794
	1925	1,037,986	406,266	3,512,007	558,914	5,515,173
	1926	1,074,260	452,018	3,535,946	635,600	5,697,824
El Paso, Tex	1922	143,171	5,843	34,879	49,088	232,981
	1923	68,974	34,378	27,238	72,832	203,422
	1924	115,865	26,355	27,923	40,992	211,135
	1925	123,373	53,750	25,627	123,927	326,677
	1926	124,815	40,846	34,167	83,265	283,093
Evansville, Ind	1922	28,437	16,010	235,041	10,623	290,111
	1923	23,640	15,386	255,853	7,842	302,721
	1924	20,805	14,830	191,202	6,326	233,163
	1925	22,790	19,010	151,805	6,690	200,295
	1926	24,215	27,489	169,423	10,133	231,260
Fort Wayne, Ind	1923	2,569	5,174	57,995	5,528	71,266
	1924	5,818	8,493	90,961	17,560	122,832
	1925	6,756	11,593	94,183	20,506	133,038
	1926	8,235	10,768	91,848	22,458	133,309
Fort Worth, Tex	1922	759,927	324,274	510,342	324,870	1,919,413
	1923	946,553	311,376	485,895	385,780	2,129,604
	1924	1,048,966	342,559	392,414	372,515	2,156,454
	1925	1,059,983	309,815	312,019	314,234	1,996,051
	1926	943,774	240,871	217,139	445,212	1,846,996
Fostoria, Ohio	1922	8,692	6,067	104,553	14,267	133,579
	1923	6,127	6,246	110,669	12,333	135,375
	1924	4,866	6,680	117,472	15,393	144,411
	1925	3,814	7,847	106,419	14,263	132,343
	1926	3,187	6,258	86,256	12,470	108,171
Indianapolis, Ind	1922	304,024	204,790	2,266,551	146,972	2,922,337
	1923	308,097	219,758	2,875,648	123,883	3,527,386
	1924	321,888	237,718	2,864,850	122,753	3,547,209
	1925	298,876	248,437	2,066,703	146,682	2,760,698
	1926	295,273	245,626	1,771,329	220,809	2,533,037
Jacksonville, Fla	1922	4,211	587	80,752	289	85,839
	1923	6,609	440	107,226	260	114,535
	1924	4,521	512	85,972	269	91,274
	1925	6,420	980	53,804	64	61,268
	1926	7,323	2,177	46,263	2,625	58,388

TABLE 8.—*Number of livestock received at 66 markets, as reported by the Bureau of Agricultural Economics*—Continued

Market	Year	Cattle	Calves	Hogs	Sheep	Total number of animals
Jersey City, N. J.	1922	236,380	436,502	447,298	1,467,611	2,587,791
	1923	191,145	481,669	512,570	1,276,303	2,461,687
	1924	220,512	490,703	534,786	1,230,246	2,476,247
	1925	220,004	524,504	466,832	1,213,391	2,424,731
	1926	189,878	518,121	356,188	1,268,768	2,332,955
Kansas City, Mo.	1922	2,443,499	539,595	2,654,959	1,574,217	7,212,270
	1923	2,631,808	576,122	3,615,205	1,671,145	8,494,280
	1924	2,471,291	571,517	2,932,941	1,569,070	7,544,819
	1925	2,409,012	549,420	2,067,038	1,499,730	6,525,200
	1926	2,183,382	433,131	2,035,828	1,761,893	6,414,234
Knoxville, Tenn.	1922	22,208	1,417	57,372	2,076	83,073
	1923	20,231	1,541	43,861	1,362	66,995
	1924	23,233	1,415	52,135	1,697	78,480
	1925	25,262	1,357	38,506	2,670	67,795
	1926	18,186	2,072	23,791	371	44,420
Lafayette, Ind.	1922	6,781	6,263	104,926	4,336	122,306
	1923	6,416	6,298	129,083	4,237	146,034
	1924	7,149	7,295	142,191	5,661	162,296
	1925	7,672	8,200	121,666	6,323	143,861
	1926	8,668	8,403	110,112	4,373	131,556
Lancaster, Pa.	1922	216,800	17,120	76,118	27,247	337,285
	1923	198,008	30,710	155,382	52,682	436,782
	1924	200,994	22,075	80,545	14,640	318,254
	1925	211,272	21,793	65,968	18,103	317,136
	1926	203,601	32,788	79,891	33,575	349,855
Laredo, Tex.	1923	13,479	1,066	2,070	1,138	17,753
	1924	8,349	3,352	3,178	3,423	18,302
	1925	13,244	2,463	2,634	3,045	21,386
	1926	10,610	3,052	2,645	3,308	19,615
Los Angeles, Calif.	1923	135,118	47,752	227,434	75,342	485,646
	1924	165,218	87,022	269,747	102,105	624,092
	1925	169,533	77,302	217,404	29,693	493,932
	1926	198,499	69,185	198,897	46,143	512,724
Louisville, Ky.	1922	168,309	114,627	497,055	318,325	1,098,316
	1923	146,124	109,432	625,646	264,837	1,146,039
	1924	131,999	98,798	470,425	213,348	914,570
	1925	136,842	103,452	295,379	229,493	765,166
	1926	117,600	97,800	281,670	230,969	728,039
Marion, Ohio	1922	8,748	6,944	109,124	13,104	137,920
	1923	4,184	5,131	102,632	10,928	122,875
	1924	2,585	3,883	82,308	11,878	100,654
	1925	2,044	3,375	54,331	8,236	67,986
	1926	1,873	3,060	56,888	16,496	78,317
Memphis, Tenn.	1922	9,428	3,212	9,645	810	23,095
	1923	19,922	2,095	84,680	1,951	108,648
	1924	15,434	3,655	80,784	1,441	101,314
	1925	19,184	5,174	65,571	4,347	94,276
	1926	35,247	12,565	54,608	2,961	105,381
Milwaukee, Wis.	1922	118,002	386,322	466,082	44,520	1,014,926
	1923	111,874	400,567	555,268	39,932	1,107,641
	1924	106,904	425,313	522,982	36,968	1,092,167
	1925	126,592	461,248	458,545	44,878	1,091,263
	1926	152,538	487,809	613,339	51,459	1,305,145
Montgomery, Ala.	1922	56,442	504	94,428	2,280	153,654
	1923	68,099	6,675	72,776	2,806	150,356
	1924	64,475	12,547	61,959	1,665	140,646
	1925	58,179	14,864	46,798	2,952	122,793
	1926	65,536	28,910	71,367	11,295	177,108
Moultrie, Ga.	1922	3,306	1,511	51,993	----------	56,810
	1923	4,207	635	33,366	1	38,209
	1924	6,198	384	29,600	363	36,545
	1925	5,844	----------	37,999	62	43,905
	1926	7,588	----------	51,602	----------	59,190
Muncie, Ind.	1925	5,731	9,442	73,926	10,783	99,882
	1926	6,224	11,633	88,075	16,634	122,566

TABLE 8.—*Number of livestock received at 66 markets, as reported by the Bureau of Agricultural Economics*—Continued

Market	Year	Cattle	Calves	Hogs	Sheep	Total number of animals
Nashville, Tenn	1922	73,416	35,373	517,007	152,196	777,992
	1923	63,678	32,000	492,130	129,453	717,261
	1924	64,174	35,704	312,118	116,376	528,372
	1925	65,894	50,304	242,834	145,398	504,430
	1926	56,346	52,602	219,040	164,907	492,895
Newark, N. J	1923	23,803	17,666	575,686	28,840	645,995
	1924	23,859	22,047	605,229	32,623	683,758
	1925	22,356	19,075	533,469	37,993	612,893
	1926	22,350	19,384	459,480	39,063	540,277
New York, N. Y	1922	70,037	187,753	1,091,099	143,334	1,492,223
	1923	70,717	145,248	1,159,888	74,549	1,450,402
	1924	60,029	157,503	1,198,723	67,783	1,484,038
	1925	64,566	157,332	928,139	108,959	1,258,996
	1926	71,159	155,626	924,216	149,463	1,300,464
North Salt Lake, Utah	1922	86,011	2,310	84,035	459,453	631,809
	1923	71,486	2,082	234,019	449,006	756,593
	1924	93,062	5,713	474,707	617,784	1,191,266
	1925	95,526	4,743	379,774	687,955	1,167,998
	1926	85,931	4,455	337,471	599,776	1,027,633
Ogden, Utah	1922	87,350	3,857	198,292	704,419	993,918
	1923	117,393	4,530	256,413	849,101	1,227,437
	1924	146,204	8,873	280,338	564,694	1,000,109
	1925	155,514	7,490	255,168	884,237	1,302,409
	1926	156,876	7,412	293,927	1,033,744	1,491,959
Oklahoma City, Okla	1922	331,758	50,583	504,378	17,888	904,607
	1923	337,927	76,609	487,856	9,280	911,672
	1924	287,275	101,164	324,607	9,218	722,264
	1925	300,464	103,652	275,526	10,130	689,772
	1926	251,785	88,188	218,088	13,753	571,814
Omaha, Nebr	1922	1,612,143	132,108	2,839,382	2,532,787	7,116,420
	1923	1,684,665	108,267	3,649,496	2,969,652	8,412,080
	1924	1,758,924	103,622	3,978,288	2,844,421	8,685,255
	1925	1,592,599	116,221	3,355,207	2,419,551	7,483,578
	1926	1,692,058	123,011	2,647,289	2,779,761	7,242,119
Pasco, Wash	1922	6,078	298	1,164	65,678	73,218
	1923	2,368	23	1,826	65,966	70,183
	1924	5,285	233	8,957	83,429	97,904
	1925	6,599	161	8,974	71,658	87,392
	1926	3,794	37	4,122	59,424	67,377
Peoria, Ill	1922	24,284	15,379	385,451	2,651	427,765
	1923	19,427	18,461	572,948	3,805	614,641
	1924	24,940	20,611	880,241	3,452	929,244
	1925	26,860	29,289	705,697	5,729	767,575
	1926	33,003	36,742	752,793	16,553	839,091
Philadelphia, Pa	1922	91,161	109,403	313,764	260,565	774,893
	1923	78,553	100,113	357,634	248,102	784,402
	1924	78,191	113,518	375,006	251,102	817,817
	1925	70,228	117,757	277,617	227,105	692,707
	1926	73,730	109,197	251,965	219,552	654,444
Pittsburgh, Pa	1922	532,198	334,566	2,690,137	1,204,217	4,761,118
	1923	414,896	405,896	3,053,870	1,045,009	4,919,671
	1924	490,642	418,438	3,038,255	978,523	4,925,858
	1925	464,057	423,369	2,311,575	909,677	4,108,678
	1926	448,248	470,127	2,059,100	1,073,115	4,050,590
Portland, Oreg	1922	126,953	12,718	224,310	205,106	569,087
	1923	146,077	22,246	286,465	179,480	634,268
	1924	145,567	29,868	356,601	199,346	731,382
	1925	148,413	27,348	265,495	178,581	619,837
	1926	143,541	20,794	231,117	181,796	577,248
Pueblo, Colo	1922	198,906	493	10,638	644,838	854,875
	1923	147,262	4,119	15,628	703,911	870,920
	1924	105,001	3,462	37,699	874,806	1,020,968
	1925	107,840	4,263	28,633	713,149	853,885
	1926	91,155	4,423	11,258	809,941	916,777

TABLE 8.—*Number of livestock received at 66 markets, as reported by the Bureau of Agricultural Economics*—Continued

Market	Year	Cattle	Calves	Hogs	Sheep	Total number of animals
Richmond, Va	1922	23,173	8,648	219,155	11,580	262,556
	1923	24,440	8,050	272,980	9,026	314,496
	1924	23,235	9,554	329,090	8,950	370,829
	1925	27,783	10,799	197,331	8,203	244,116
	1926	22,026	14,656	182,337	9,651	228,670
Roanoke, Va	1923	1,469	83	8,534	4,160	14,246
	1924	611	120	9,864	89	10,684
St. Joseph, Mo	1922	554,095	100,457	2,060,680	729,784	3,445,016
	1923	607,829	100,730	2,456,962	979,488	4,145,009
	1924	602,349	117,483	2,234,366	1,088,731	4,042,929
	1925	608,616	125,132	1,672,530	1,142,857	3,549,135
	1926	563,284	115,799	1,461,713	1,302,746	3,443,542
South St. Paul, Minn	1922	929,847	457,085	2,522,972	498,891	4,408,795
	1923	839,032	508,804	3,338,413	453,917	5,140,166
	1924	789,526	533,860	3,751,395	475,821	5,550,602
	1925	994,905	641,281	3,636,934	545,296	5,818,416
	1926	1,180,240	729,705	3,450,637	772,932	6,133,514
San Antonio, Tex	1922	125,504	72,496	63,118	66,127	327,245
	1923	95,013	67,850	61,122	22,599	246,584
	1924	107,931	74,857	63,789	18,302	264,879
	1925	93,003	73,496	55,951	10,735	233,185
	1926	94,514	50,552	39,447	13,966	198,479
Seattle, Wash	1922	44,323	2,165	151,351	69,581	267,420
	1923	51,920	3,575	218,038	85,757	359,290
	1924	58,336	5,203	274,639	99,745	437,923
	1925	50,795	6,206	255,840	77,944	390,785
	1926	53,720	9,954	208,105	87,591	359,370
Sioux City, Iowa	1922	690,942	56,041	1,855,829	222,748	2,825,560
	1923	714,008	45,486	2,988,895	215,604	3,963,993
	1924	797,935	37,806	3,732,178	309,584	4,877,503
	1925	844,797	51,964	3,395,934	359,830	4,652,525
	1926	884,522	84,340	2,474,981	448,665	3,892,508
Sioux Falls, S. Dak	1922	30,279	2,705	532,675	1,660	567,319
	1923	25,631	4,832	503,108	5,197	538,768
	1924	12,084	1,812	121,990	4,862	140,748
	1925	21,220	3,268	191,532	2,652	218,672
	1926	29,918	6,248	287,766	8,015	331,947
Spokane, Wash	1922	44,296	4,323	47,588	63,010	159,217
	1923	40,047	4,536	82,120	27,820	154,523
	1924	48,125	6,603	132,990	48,016	235,734
	1925	53,496	6,659	166,528	37,014	263,697
	1926	47,286	7,861	101,764	56,995	213,906
Springfield, Ohio	1923	4,256	2,793	63,925	9,325	80,299
	1924	4,402	4,786	91,211	13,970	114,369
	1925	5,119	7,957	108,922	15,823	137,821
	1926	6,285	7,528	124,273	25,944	164,030
Toledo, Ohio	1922	16,428	8,759	140,175	20,050	185,412
	1923	17,430	7,744	158,049	13,173	196,396
	1924	18,538	6,904	154,176	27,729	207,347
	1925	16,881	7,090	126,155	20,304	170,430
	1926	19,087	8,483	111,497	10,812	149,879
Washington, D. C. (Benning Stockyard)	1922	15,866	12,663	131,523	20,511	180,563
	1923	16,612	15,267	165,616	17,183	214,678
	1924	16,659	16,330	192,604	15,934	241,527
	1925	19,323	17,170	139,780	14,288	190,561
	1926	16,506	15,785	119,012	13,241	164,544
Wichita, Kans	1922	323,254	83,926	569,687	82,476	1,059,343
	1923	339,000	77,582	706,052	119,790	1,242,424
	1924	310,022	78,962	733,541	83,851	1,206,376
	1925	333,825	82,990	630,806	89,253	1,136,874
	1926	262,109	67,580	523,884	125,295	978,868

TABLE 8.—*Number of livestock received at 66 markets, as reported by the Bureau of Agricultural Economics*—Continued

TOTAL RECEIPTS

Year	Cattle	Calves	Hogs	Sheep	Total number of animals
1922	16,753,030	5,984,192	43,390,760	21,252,932	87,380,914
1923	16,975,406	6,210,158	55,248,675	21,855,991	100,290,230
1924	17,158,273	6,522,496	55,243,203	22,043,596	100,967,568
1925	17,106,813	6,949,897	43,732,335	21,995,643	89,784,688
1926	17,025,483	6,837,231	39,532,396	23,758,247	87,153,357

NOTE.—The following markets were within the jurisdiction of the Packers and Stockyards Administration on December 31, 1926, but no figures are given in the Crops and Markets reports: Columbia Stockyards, Columbia, S. C., posted November 1, 1921 (no figures for 1925 and 1926); Drovers Union Stockyards, Columbus, Ohio, posted November 1, 1921 (no figures for 1925 and 1926); Galesburg Horse & Mule Co., Galesburg, Ill., posted April 16, 1925; Meridian Union Stockyards, Meridian, Miss., posted May 1, 1926; Union Stockyards, San Francisco, Calif., posted December 3, 1923; Springfield Stockyards, Springfield, Ill., posted February 11, 1926; Springfield Stockyards, Springfield, Mo., posted December 3, 1925; Stockton Feed Yards, Stockton, Calif., posted December 17, 1926.

FIELD OFFICES

The following is a list of field offices where one or more representatives of the Packers and Stockyards Administration are located. Producers of livestock or others interested who desire information may obtain it by addressing the supervisor, Packers and Stockyards Administration, or by calling in person at the point most convenient.

Atlanta, Ga., Atlanta Union Stockyards, Building D. Also supervises Augusta and Moultrie, Ga.; Chattanooga and Knoxville, Tenn.; Columbia, S. C.; Jacksonville, Fla.; Montgomery, Ala.

Buffalo, N. Y., 27 Livestock Exchange Building. Also supervises Detroit, Mich.

Chicago, Ill., 999 Exchange Avenue, Union Stockyards. Also supervises Galesburg and Peoria, Ill., and Milwaukee, Wis.

Cincinnati, Ohio, 9 Livestock Exchange Building, Stockyards Station. Also supervises Dayton, Fostoria, Marion, Springfield, and Toledo, Ohio.

Cleveland, Ohio, 29 Livestock Exchange Building.

Denver, Colo., 414 Livestock Exchange Building. Also supervises North Salt Lake and Ogden, Utah; Pueblo, Colo.

Fort Worth, Tex., 233 Livestock Exchange Building. Also supervises Amarillo, Dallas, El Paso, Laredo, San Antonio, Tex.

Indianapolis, Ind., 238 Livestock Exchange Building. Also supervises Evansville, Fort Wayne, La Fayette, Muncie, Ind.

Kansas City, Mo., 923 Livestock Exchange Building. Also supervises Springfield, Mo.

Los Angeles, Calif., 209 Livestock Exchange Building, Union Stockyards. Also supervises San Francisco, South San Francisco, Stockton, Calif.

Nashville, Tenn., 214 Livestock Exchange Building. Also supervises Arabi, La.; Louisville, Ky.; Memphis, Tenn.; and Meridian, Miss.

National Stock Yards, Ill., 58 Livestock Exchange Building. Also supervises Springfield, Ill.

New York, N. Y, Dodge Building, Room 906, 53 Park Place. Also supervises Albany, N. Y.; Boston, Mass.; Lancaster and Philadelphia, Pa.; Jersey City and Newark, N. J.

North Portland, Oreg., 106 Livestock Exchange Building. Also supervises Pasco, Seattle, and Spokane, Wash.

Omaha, Nebr., 306 Livestock Exchange Building.

Pittsburgh, Pa., 306 Livestock Exchange Building.

Sioux City, Iowa, 322 Livestock Exchange Building. Also supervises Sioux Falls, S. Dak.

South St. Joseph, Mo., 415 Livestock Exchange Building.

South St. Paul, Minn., 530 Livestock Exchange Building.

Washington, D. C., 1316 B Street SW. Supervises Baltimore, Md.; Benning, D. C.; and Richmond, Va.

Wichita, Kans., 45 Livestock Exchange Building. Also supervises Oklahoma City, Okla.

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REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., August 13, 1927.

SIR: I have the honor to submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1927.

Respectfully.

WM. A. TAYLOR,
Chief of Bureau.

HON. W. M. JARDINE,
Secretary of Agriculture.

WORK AND ORGANIZATION

The Bureau of Plant Industry is primarily a research organization devoted to the investigation and improvement of plant production and plant industries, including fruits, fruit trees, grain, cotton, tobacco, vegetables, grasses, and forage, drug, poisonous, fiber, and other plants. This work includes improvement by breeding and selection; the introduction of seeds and plants procured through foreign exploration; experimentation in methods of culture and rotation systems adapted to irrigation, dry-land, or other systems of agriculture; and investigations in handling, storing, shipping, processing, or otherwise utilizing plants or plant products. Investigations are also conducted upon the injury to crops caused by fungous, bacterial, and virus diseases, and by nematodes, weeds, and abnormal environmental conditions. Campaigns to control or eradicate certain plant diseases are conducted in cooperation with the States concerned. The enforcement of the Federal seed act is the only regulatory activity of the bureau and requires the investigation of domestic production of seeds and of seeds in commerce or offered for import.

A comprehensive description of the recent progress of the bureau's activities would necessitate a review of the results described in publications of the department or in other articles published by the specialists of the bureau that report in detail the progress of the various lines of investigation. A list of the publications issued during the year is appended.

The appropriations available for the work of the bureau for the year were apportioned, as authorized by law, to the several types of work under way, approximately as follows:

Research work	$3,091,695
Control and eradication work	796,910
Regulatory work	19,450
Total	3,908,055

The work of the bureau has been carried on by the following organization:

Office of the chief	William A. Taylor, chief of bureau. K. F. Kellerman, associate chief of bureau. H. E. Allanson, assistant chief of bureau.
Pathological laboratory	Directed by the associate chief of bureau.
Mycology and disease survey	C. L. Shear, senior pathologist in charge.
Fruit diseases	M. B. Waite, senior pathologist in charge.
Citrus canker eradication	Directed by the associate chief of bureau.
Forest pathology	Haven Metcalf, senior pathologist in charge.
Blister rust control	S. B. Detwiler, senior pathologist in charge.
Vegetable and forage diseases	Directed by the associate chief of bureau.
Crop physiology and breeding	W. T. Swingle, senior physiologist in charge.
Cotton, rubber, and other tropical plants	O. F. Cook, senior botanist in charge.

Fiber plants	L. H. Dewey, botanist in charge.
Drug, poisonous, and oil plants	W. W. Stockberger, senior physiologist in charge.
Plant geography and physiology	Directed by the associate chief of bureau.
Nematology	N. A. Cobb, senior nematologist in charge.
Seed laboratory	Edgar Brown, senior botanist in charge.
Cereal crops and diseases	C. R. Ball, senior agronomist in charge.
Tobacco and plant nutrition	W. W. Garner, senior physiologist in charge.
Alkali and drought resistant crops	T. H. Kearney, senior physiologist in charge.
Sugar plants	E. W. Brandes, senior pathologist in charge.
Botany	F. V. Coville, senior botanist in charge.
Dry-land agriculture	E. C. Chilcott, senior agronomist in charge.
Western irrigation agriculture	C. S. Scofield, senior agronomist in charge.
Horticulture	L. C. Corbett, senior horticulturist in charge.
Gardens and grounds	J. W. Byrnes, assistant in charge.
Arlington Experiment Farm	E. C. Butterfield, horticulturist and superintendent in charge.
Foreign plant introduction	David Fairchild, senior agricultural explorer in charge.
Forage crops	R. A. Oakley, senior agronomist in charge.
Biophysical laboratory	G. N. Collins, senior botanist in charge.

FRUITS

APPLES

STOCKS

In view of the prospective need of developing domestic sources of seed for apple stocks, the relative merits of the seedlings of different apple varieties have received a rather large measure of attention. That there is marked difference in the seedlings of different varieties has been demonstrated. As the French crab is the apple stock in general use, that naturally has been the principal stock with which the merits of other possible apple stocks have been compared. Seedlings grown in considerable quantity of the following apple varieties have proved either as vigorous as or more vigorous than French crab seedlings: Northern Spy, Patten, McIntosh, Lawver, Delicious, Yellow Newtown, Ben Davis, Winter Banana, Missouri Pippin, Grimes Golden, Gano, and Jonathan apples and Florence, Red Siberian, and Yellow Siberian crabs. As examples of seedlings less vigorous than the French crab, those of Illinois Favorite, Paragon, Tompkins King, and. Baldwin apples and Entz crab may be mentioned. Seedlings of most of the named varieties of apples have shown less variation than seedlings of French crabs.

The most promising apple stock selection which has thus far been made is one chosen from a lot of Northern Spy seedlings grown in 1923. The progeny from this individual selection makes an unusually rapid growth, and there is rather convincing evidence that it is markedly resistant to woolly aphis. Furthermore, it is readily propagated by root cuttings. Many other selections have been made, but on subsequent testing the progenies have shown some weakness, so that the most of the earlier selections have been discarded.

CROWN GALL

Experiments on the treatment of crown gall in apple nurseries with organic mercury were repeated. Results obtained in controlling malformations, regardless of their pathogenic or nonpathogenic origin, have been fairly successful only with the use of the organic mercury compound treatment. Limited trials, however, in the use of adhesive tape wrap as recommended by other investigators gave very good control, but it is not known that this method of wrapping is practical for commercial work.

SCALD

Records were taken on the apple-scald experiments started the preceding fall. The experiments in the Eastern States were largely with shredded oiled paper in barrel and basket packages. The tests covered the Grimes Golden, York Imperial, Stayman Winesap, Rhode Island Greening, and Arkansas varieties, using fruit from Virginia, Maryland, Delaware, and New York. The results showed that the shredded oiled paper could be relied upon to give good scald control when the paper was well distributed in the package. Records were also obtained on packages put up by the growers, and it was found that where the distribution of the paper was poor the scald control was not satisfactory. Various reports received from growers showed that the shredded paper had greatly increased the market value of apples; some stated 50 to 75 cents, others $1 to $1.25 per barrel.

WATER CORE

Storage experiments had been started the previous fall with different varieties of apples in the Pacific northwest having different stages of water core. Records were taken on

these at different times to determine the extent to which the disease had disappeared and also the extent to which the storage life of the apples had been shortened because of the presence of water core. It was found that while in mild cases the disease generally disappeared in storage, it was sometimes followed by internal breakdown, especially in the Stayman Winesap and Jonathan varieties.

Several varieties of apples were picked at various degrees of maturity and records taken upon water core, and it was found that as the apples passed their best picking season water core developed very rapidly, especially in the Stayman Winesap and Jonathan varieties. Records were taken upon the occurrence of water core under different systems of pruning, with results indicating that the severe pruning with resultant exposure of most of the apples to continued sunlight may greatly increase the development of water core.

SPRAY RESIDUES

In its trade relationships, probably no activity concerning apples has had a more far-reaching effect and has been of greater importance to all interests concerned than the investigations of practicable and effective methods of removing arsenical spray residues from apples and pears. Because of the reaction of export as well as domestic markets to the presence of arsenical spray residues on the fruit, the problem of removing such residues so that the quantity remaining would be within a specified tolerance was very definitely projected into the problem of handling and marketing apples and pears. The problem was particularly acute with respect to fruit grown in arid or semiarid regions where it was likely to carry larger spray residues than in the humid sections where more or less frequent rains tend to wash the residues from the fruit before it is harvested. Moreover, climatic conditions in their relation to the development of insects probably necessitate a heavier application of arsenical sprays to fruit in some of the semiarid fruit districts. While methods of removing spray residues have not yet been perfected, the investigations have made material contributions to the solution of the problem.

BERRIES

STRAWBERRIES AND RASPBERRIES

The small-fruit work, particularly in the line of breeding for improved varieties, has shown progress that is tangible. Many thousands of strawberry seedlings resulting from handmade crosses have been under observation during the last several years, and during the last year about 6,000 to 7,000 seedlings were studied with respect to their plant and fruit characters. About 50 selections from the earlier breeding work have been placed for testing with experiment stations, nurserymen, and others with a view to determining their range of adaptability. Some 500 selections have been reserved for further study before deciding what ones may possess sufficient merit to justify placing elsewhere for testing.

About 11,000 raspberry seedlings, the results of handmade crosses, have been under observation, but the raspberry-breeding work is not as far advanced relatively as is the strawberry work. Nearly 20 acres of land are occupied in the growing and handling of the small-fruit plant material at the United States Plant Field Station, Bell, Md.

BLUEBERRIES

In the work of blueberry breeding, two of the newer hybrid varieties produced berries slightly in excess of seven-eighths of an inch in diameter. These varieties have not yet been named but are carried in our records as 1257–A and 1443–A.

The examination of the chromosomes of our native species of blueberries has disclosed the existence of at least three groups of species differing in the number of chromosomes. One of these groups has 12, another 24, and another 36 chromosomes. The species of the 12-chromosome group will cross with one another, as will those of the 24-chromosome group, but a species of the 12-chromosome group will not cross with one of the 24-chromosome group. Many hybrids have been made between the rabbit-eye blueberry of Florida, a species of the 36-chromosome group, and some of the large-berried hybrids belonging to the 24-chromosome group, but from the many plants that have been brought into flower from these crosses not one has produced fruit, notwithstanding the most careful pollination. Thus far, therefore, all attempts to improve the rabbit-eye blueberry of Florida by cross-breeding with other species have failed. The prospect of success in the improvement of this species depends on the discovery of some other promising wild species having 36 chromosomes.

CRANBERRIES

Because of the great importance of false blossom and the general interest among cranberry growers, work on cranberry diseases was directed chiefly toward that disease. A survey of sucking insects was conducted in Massachusetts, Wisconsin, and Washington, with the cordial consent of the Bureau of Entomology and the cooperation of the States concerned. This survey showed the very great abundance of leaf hoppers belonging to the genera Euscelis and Platymetophius on bogs infected with false blossom in Massachusetts and Wisconsin, their relative scarcity on bogs not infected with the disease in these same States, and their apparent absence in Washington and Oregon. This fact is of great interest, since false blossom apparently does not spread in Washington and Oregon.

CITRUS

NEW STOCKS

The recently increased interest in "kid-glove" citrus fruits such as the tangerine, Satsuma, and mandarin, resulting in a rapid increase in the acreage planted to these types of orange, has emphasized the need for more careful attention to stocks. A Chinese mandarin orange, the so-called "honey" orange of Swatow, introduced into Florida under a trade name, has proved a disappointment in spite of the fact that it is recognized as the finest type of citrus fruit grown in the Orient. Investigations recently made in China have brought out the fact that this orange, both in China and in Formosa, is propagated on a special stock, a sour mandarin, not yet known in the United States. Introductions of this sour-mandarin stock have now been made, and plants will soon be given a field trial as a stock for the "honey" orange and similar mandarin oranges.

After several years' preliminary work, it proved feasible during the latter part of 1926 to procure from Japan, through the cooperation of the Japanese authorities, a very fine collection of the different strains of Satsuma oranges grown in that country and also a number of independently originated mutations of the Satsuma, known in Japan as Wase Satsuma. These Wase mutations bear large, juicy fruits that ripen nearly a month earlier than the ordinary Satsuma and are the earliest oranges of good quality produced in Japan. They offer very great promise for commercial culture in Alabama, northern Florida, Mississippi, and other parts of the Gulf coast.

Trials of the new varieties of Satsuma, especially the extra-early Wase variety mentioned, have indicated the importance that these varieties are to assume in the Gulf coast territory of northwestern Florida and westward. In this region it is important that the crop be picked and shipped by December 1, to avoid losses from early cold sufficient to injure fruit though not dangerous to the trees themselves. Early varieties that will permit the harvest to begin two to three weeks earlier than at present would be desirable in many ways, supplying a market need when there is scarcity of good oranges and permitting the Satsuma movement to be practically completed before the heavy movement of round oranges from Florida and California gets under way. While the preliminary trials of these extra-early varieties and strains of Satsuma are encouraging, other tests, including stock adaptability, production, and shipping quality, must, of course, be awaited before selections can be made accurately. The additional strains obtained from Japan will afford an excellent opportunity for selecting the best possible type for commercial propagation in the United States. This is especially necessary because of the peculiar nature of this extra-early variety, the Wase, which originated as a bud sport of the Owari variety more commonly grown in Japan, and shows some tendency to reversion.

CANKER ERADICATION

The campaign for the eradication of citrus canker, conducted by this bureau in cooperation with the Gulf States, has progressed satisfactorily. Mississippi and Alabama are apparently free from canker, as no infections have been found in those States for several years. However, a rigid inspection is being continued of all orchards, nurseries, and citrus plantings. Florida reported the discovery of two infected orange trees at Sebring in December, 1926. A large corps of inspectors was immediately detailed to this vicinity, but no other infections were discovered. This was the first new infection reported from Florida since March, 1925, which indicates that the disease is well under control in that State. Louisiana has not reported any new infections, but there are a number of properties still

classed as "infectious," and major efforts have been devoted to these properties, where all trees have been uprooted and no new trees allowed to be planted in the same soil or in close proximity to soil from which canker-infected trees have been removed. In Texas the work was concentrated in the southern part of the State, where heavily infected trifoliata hedges of long standing were removed and small infections around these hedges were eradicated, with the result that conditions are better in Texas now than at any time since 1913, when citrus canker was first discovered there.

The eradication of the last traces of canker in the different States is proving to be a difficult and tedious process, but it appears reasonable to expect that these local outbreaks will become more and more infrequent and that eventually complete eradication will result.

DATES

POLLINATION

The outstanding development of the year in connection with the work on date growing has been the full confirmation of the amazing influence of pollen on the development of the fruit of the date palm. The second year of scientific work, just closed, has been carried on with every precaution to prevent accidental error and has shown beyond question that different kinds of pollen yield qualities of dates differing widely in important commercial attributes. It has been shown, for instance, that pollen from certain male trees causes the production of small seeds and small fruits that ripen early, and that pollen from other trees causes the production of large seeds and large fruits that ripen late. The seeds vary as much as 25 per cent in size through the effect of pollen and the fruit as much as 10 per cent, but the most important effect observed so far is the change in the time of ripening. This difference in time of ripening often amounts to several weeks and is occasionally sufficient to decide whether the crop can be ripened properly, cured, and sold, or will be lost completely as the summer rains begin. Inasmuch as all dates are artificially pollinated, it costs no more to use one kind of pollen than another, so that the results cited may be attained by any grower by the use of suitable pollen and without extra cost.

MATURATION AND STORAGE

A considerable increase in the production of Deglet Noor dates in the Coachella Valley of California in the near future is indicated. This makes it imperative to introduce certain changes in the handling of the crop in order to enlarge the market, standardize the quality of the fruit, and adjust the labor situation incident to the present system of packing and marketing the fruit in a comparatively short period. Results of experiments conducted during the last two seasons on the maturation and storage of this date indicate that the fruit may be graded according to certain physical characteristics whereby those grades which will best retain their flavor and appearance when stored for four or five months can be reserved for this purpose and the other grades marketed as soon as possible. The industry has not only recognized the necessity of storing dates as an important step in solving the marketing problem but has already made a move in that direction. The results of the experimental work should therefore be of value by indicating which type of fruit can best be utilized for storage purposes. Examinations of several grades of fruit stored since the last harvest under different conditions are now being made.

FIGS

As a result of the campaign which has been carried on for the last 15 years in the Southwestern States, a number of extremely promising new figs have been originated, some of them showing every indication of being suitable for culture on a commercial scale. It must be remembered in this connection that fig varieties have been originated for the most part purely by chance and haphazard crossings, largely because the fig is a dioecious plant and it is not possible to cross directly two standard fig varieties. All that can be done is to fertilize them from different caprifig trees and test the seedlings in the hope of finding superior offspring. Some of the figs obtained in this way have given very great promise, and arrangements are being made to test them in orchards alongside of the standard varieties.

GRAPES

VINIFERA

Breeding work has been undertaken in an endeavor to produce a fully sat-

isfactory seedless grape of the Muscat type, varieties having larger and more compact clusters than the Muscat type, and also red-juiced varieties of that type. A few seedlings from earlier breeding work are being grown at the United States Experiment Vineyard, Fresno, Calif., and some 1,200 seeds were obtained from crosses made in 1926. Probably there is no phase of the vinifera-grape work which has been in progress for a considerable length of time that is so important at present with respect to the future of the industry in California as the resistant-stock studies. The phylloxera is gradually making inroads and probably occurs in all of the grape counties in central California, even though there are a few counties in which it has not yet been actually observed. The growers have been slow to realize the importance of resistant stocks. This is probably due to the fact that suitable resistant stocks for many of the conditions have not been available and probably are not yet available in adequate quantities. The Franco-American direct-producing varieties of grapes have been found to be, with few exceptions, only partially resistant to phylloxera.

As the need for resistant stocks becomes more generally recognized and the relation of such stocks to the future welfare of the industry becomes better understood, the propagation of grape varieties on them becomes a matter of primary concern. A method of bud grafting has been worked out or applied in the experiment vineyards at Fresno and Oakville, Calif., which has several advantages over the practice of crown grafting that has generally been followed in field practice where there has been occasion to graft grapes in the field.

MUSCADINE

In the vineyard at the Coastal Plains Branch Station of the North Carolina State Department of Agriculture at Willard, in cooperation with which the work with muscadine grapes is being carried on, it has been shown over a period of several years that excessive nitrogen stimulates wood growth at the expense of fruit production, but without nitrogen the wood growth is so weak that the vines lose vitality and fail to produce a normal crop of fruit both in size of berry and in size of crop. Tests extending over a period of years have shown the value of regular, systematic, but moderate pruning. The more common practice heretofore among the growers of this type of grape has been to do little or no pruning, the belief prevailing that pruning would result in the death of the vines. The pruning tests have demonstrated, however, that properly pruned vines bear regular annual crops of normal size in contrast to the crops irregularly produced on unpruned vines which vary in their production from no crop at all to an overloaded crop in some years.

LIGHTNING INJURY

Injury by lightning caused considerable excitement among some grape growers in California, who naturally thought a new disease had suddenly made its appearance and might spread through the vineyard. Bureau specialists correctly diagnosed the trouble. In one case the charge traveled perhaps 200 feet along the trellis wire, as indicated by the injured canes.

SPRAYING EXPERIMENTS

The addition of glue or glucose sirup did not increase the toxicity of lime-sulphur solution to the foliage of Malaga grapes. A 2½ per cent emulsion of water-white hydrocarbon oil product added to the lime-sulphur at the rate of 1 to 100 caused serious burning of the foliage, although neither 2½ per cent oil nor 1½ per cent lime-sulphur caused serious damage. It appears that the sulphur goes into solution in the oil and the oil penetrates, taking the sulphur with it.

MARKET DISEASES

In cooperation with the Bureau of Agricultural Economics, studies of diseases and other conditions affecting California grapes during the marketing process were made both in the field and on the market. These studies included holding tests to determine the effect of various diseases on the keeping quality of grapes at cold-storage temperatures and whether and to what extent the raisining process can go on at storage temperatures. This work has already given results which are of value to the Federal food-products inspection service, and through that service have been passed on to growers, shippers, carriers, and receivers.

PEACHES

BREEDING

In California at the present time the peach is occupying an especially promi-

nent place among the deciduous fruits, particularly because of the extensive canning industry of that State. It is held by many in a position to take note of developments that the fruit produced by the canning varieties is not now as satisfactory as it formerly was. This condition may be due in part to a deterioration of the fruit, but it may also be due partly to a perhaps unconscious raising of the standards of the canning industry. Special emphasis has therefore been placed on a study of some of the extensive peach orchards devoted to the canning varieties, with a view to locating, if possible, mutations which might represent variations that would be of value to the growers of canning peaches as well as to the canning industry. In one extensive orchard there have been found four limb sports which are considered superior to their parent varieties. The real value of these sports, however, can be determined only by further testing. A number of mutations which have been located are, on the other hand, apparently inferior to the parents on which they have developed.

Because of the present situation with respect to the peach industry in California, more attention has been given to peach breeding than to the development of improved varieties of other kinds of fruit by this means. The orchard planted at Leland Stanford Junior University has now come into bearing and is furnishing breeding material not otherwise available. Some of the trees resulting from earlier crosses have come into bearing and are available for use as parents in further breeding. Seven crosses of peaches made in the earlier part of the work have shown enough promise so that trees have been propagated for testing under commercial conditions.

BACTERIAL SPOT

Bacterial spot of peaches has been increasing in importance in southern Indiana. The most susceptible varieties were the J. H. Hale and Elberta, the former being especially susceptible. In 1926 it was estimated that within the Vincennes district 5 per cent of the crop of Elberta and 30 per cent of the crop of J. H. Hale was affected. At Fort Valley, Ga., the disease was very destructive in certain orchards, but its attacks were limited to orchards on light soil or in poor condition, due to other factors. At Vincennes, Ind., the original spray program of approximately 100 different mixtures has been reduced to one of 9. Some of these show considerable promise, but it is feared that even if a spray is found which will control the disease, so many applications may have to be made that the treatment will be too expensive.

PHONY DISEASE

Studies of the phony disease of the peach were continued. It was found that there was no resistance in the buds or scions of the apparently resistant trees from which propagating material was taken. Growth from the buds or scions takes on typical phony characteristics in phony trees and normal characters in normal trees. The resistance, if it really exists, lies in some character or capability of the roots. No typical cases of phony disease have been found outside of Georgia.

WINTER INJURY

In January, 1926, very remarkable winter injury to peach trees in the sand-hill district of North Carolina was studied. This injury, which certainly occurred in the fall, possibly late in the fall of 1925, consisted only of killing the cambium on the trunks of the trees, usually in a narrow zone reaching from the ground line upward only a few inches. In many cases the trees were girdled and killed, yet the sapwood was white and uninjured immediately under the cambium. This injury, which was very severe, killing thousands of trees and sometimes ruining whole blocks of peaches, was complicated by heartwood injury of January, 1924. There was a further remarkable case of "bleeding" from pruning wounds, evidently brought about by the same physiological conditions which caused the cambium to be killed and the bark lifted and which may also have been influenced by the previous heartwood killing. It is noteworthy that during 1924 and also during the winter of 1925–26 the North Carolina peach orchards suffered from winter injury very much more than the orchards of Virginia, Pennsylvania, and New York, and also more than those south of North Carolina. There was considerable correlation found between the relation of the subsoil and the water table, and in one case at least the grower promptly installed a drain to draw off a pocket of water which had maintained the water table within 18 inches of the surface.

PEARS

The application of the pressure-test method of determining maturity of fruits for storage and for long-distance shipment has been given a good deal of attention, with results which promise to mean very much to the industries concerned. In some sections of the Northwest the pressure test has been adopted by the Federal and State inspection services for use at shipping points. A pressure-test table for different fruits was drawn up with the cooperation of the Federal and State inspection services of Washington and Oregon, where this method of determining the maturity of fruit for harvest has been given particular attention. The storage quality as well as the dessert quality of pears at different degrees of maturity, as indicated by different pressure tests, has been investigated to the extent of determining that there is a close coordination between the maturity at different stages as revealed by the pressure test and the behavior of the fruit in storage. This has a close bearing on the harvesting of the fruit for the fresh-fruit trade as well as the handling of fruit intended for canning.

PLUMS AND PRUNES

An extended study of the relation of maturity at harvest to the shipping and dessert quality of plums and peaches grown in California was brought to a sufficient stage of completion to justify publication of the results so far as they related to plums and prunes. The aim in establishing picking-maturity standards is to permit the fruit to advance toward maturity as far as possible before picking and yet enable it to reach distant markets in good condition. If the fruit is picked when too immature, the dessert quality does not develop. If it is overmature when picked, its carrying quality is insufficient to enable it to reach distant markets in good condition.

An extensive study of the response to pruning the trees of different plum and prune varieties on the Pacific coast has been completed. This is not a study primarily of pruning, but rather a study of varietal characteristics involving the particular manner in which the trees bear the fruit and their response to soil, climatic, and moisture conditions and the relation of pruning to the tree characteristics and conditions. The same variety under different conditions grows in diverse ways and requires different pruning to gain the same objective. As a result pruning practices are employed for the most part empirically. This study is intended to furnish a sound basis for pruning practices to be applied to trees of different varieties when grown under different conditions so as to bring about optimum results from the standpoint of fruit production.

NUTS

ALMONDS

The almond-variety studies served among other things to emphasize the fact that even the best of the varieties available have rather serious faults or weakness. About 1,200 trees resulting from crosses have been planted in orchard form, with an additional number of such seedlings becoming ready for planting for trial each season. Obviously, many eliminations will be made as soon as these seedlings begin to bear enough to demonstrate the character of their product. It is expected, as is always the case in breeding work, that a very large percentage of the seedlings will prove to be either no better than or actually inferior to the parent material.

WALNUTS

A study of Persian walnut varieties and varietal improvement has been undertaken on a small scale on the Pacific coast. The observations have been carried far enough to make it appear that no varieties of the Persian walnut now available are well adapted to the hot interior valley districts in California, and the growers in those sections can not as a rule expect to produce as many first-class, light-colored kernels as can be done in regions under coastal influences. The fact that the California black-walnut species are much better adapted to the hot interior valleys of California than is the Persian walnut suggests the possibility that breeding, using selections of the Persian and the California species as parents, may yield varieties of walnuts fully adapted to the hot interior valleys.

PECANS

At the United States Pecan Field Station at Philema, Ga., a comprehensive stock project inaugurated in 1923 has reached the stage where the stocks are being used in propagation and

some permanent experimental test plantings have been made. The development of a method of growing pecan stocks from seed under shade as a means of preventing loss from the burning of the pecan seedlings apparently as a result of excessive heat of the sun marks a decided advance in this particular field.

The fertilizer investigations in pecan orchards of southern Georgia, Florida, and southern Alabama have led to the formation of a fertilizer practice which is being generally followed by growers in these regions. These experiments so far have shown that the following fertilizer practice would seem to yield profitable results: A fertilizer containing 8 to 9 per cent of phosphoric acid, 4 to 5 per cent ammonia, and 3 to 4 per cent potash should give good results when used in pecan orchards where leguminous cover crops are grown and turned under. The growing of cover crops for manuring is essential, for it keeps up the organic-matter content of the soil, which makes it more retentive of moisture, besides supplying nitrogen to the growing trees.

Studies were made of the morphology and taxonomy of the pecan-scab fungus. It had been thought that the fungus produced its conidia singly on short conidiophores, as does the apple-scab fungus, but these studies have shown that the pecan-scab fungus produces its conidia in chains in a manner similar to that of the peach-scab fungus, and it may be congenerically related to that fungus. Dusting experiments with a mixture of monohydrated copper and lime were conducted with promising results. Two applications of 3–3–50 Bordeaux mixture gave almost perfect control of scab. Neither Bordeaux mixture nor the dust caused any foliage injury during the season of 1926. On account of the large size of the trees it is difficult to spray pecans, and the success of the dust is therefore gratifying, since the dust can be applied much more easily and rapidly than the spray.

VEGETABLES

CABBAGE

The work on midseason varieties of yellows-resistant cabbage has advanced to a point where progenies of each of three types (All Head Early, Glory, and Late Copenhagen) which are apparently homozygous for resistance and very uniform in other characters are ready for the process of increase. Advance lots of each of these strains (not quite so highly selected) have been multiplied by the National Kraut Packers' Association and have been made available by them for general use in 1927. They are being introduced under the names of All Head Select, Globe, and Marion Market.

Studies on the life history of black rot are yielding the important evidence that incipient infection of the young seedling may result in the bacteria residing in the growing plant for several weeks without outward symptoms and giving rise to late-season epidemics. This throws new light on the rather common outbreaks in midseason or later which have heretofore been attributed to recent local infection. The importance of clean seed and a clean seed bed is strengthened, and the impracticability of detecting or sorting out affected plants at the time of transplanting is established.

BROCCOLI AND CAULIFLOWER

Continued cooperative tests in Virginia, North Carolina, and South Carolina have given results which lend encouragement to the possibility of broccoli proving to be adapted to fall planting for early spring marketing in portions of the Coastal Plains region. Some varieties of cauliflower may also prove to be adapted for handling in this way. Neither cauliflower nor broccoli is grown commercially in the Coastal Plains region at the present time. Certain strains or varieties have proved as hardy as the Wakefield strains of cabbage, indicating from a temperature standpoint an adaptation similar to that of cabbage.

Considerable attention has been given to the production of cauliflower seed of certain special strains under glass at the Arlington Experiment Farm. One of the special problems has been to develop plants which would reach the seed stage in the season which would be most favorable to seed production. Results indicate that planting during November will give plants which yield a very much larger quantity of seed than if planted either earlier or later. Through the cooperation of seedsmen and growers an effort is being made to find locations in the United States which are suitable for the outdoor production of cauliflower seed.

CELERY

Blackheart of celery is of more economic importance than all other celery diseases, because heretofore it had not

yielded to any practical control measures. It is now definitely established that blackheart is caused by unbalanced water relations, as it appears after prolonged droughts, or following the application of too much water after droughts. Old plants are more subject to the disease than young ones. The old Golden Self-Blanching variety is also less resistant than Meisch's Special or any of the Special varieties. Control measures, consisting mainly of planting celery that is resistant to the disease and of carefully controlling the water supply during the entire growth of the plant, have been adopted by many growers with considerable success.

LETTUCE

Investigations were continued on brown blight, a destructive new disease of lettuce in the Imperial Valley of California, where a large percentage of the winter lettuce supply of the United States is grown. Resistant strains, developed by selection, gave very satisfactory trial plantings in the 1925–26 winter crop. From stock seed of the two best strains, placed in the hands of growers and seedsmen, several thousand pounds of seed were produced in the summer of 1926, and several hundred acres were planted with this resistant seed for the 1926–27 winter crop.

Lettuce mosaic was found to be readily transmitted by the lettuce aphis, *Myzus persicae*, the incubation period being about 15 to 19 days. It was found that most of the fields when set contained about 1 to 3 per cent mosaic plants. In the fall plantings there had appeared to be little dissemination of the disease, but after December 15 it spread rapidly, due apparently to the appearance of the lettuce aphis. The first infection found in the fields corresponded to the amount of mosaic found in the seed beds.

PEANUTS

As a result of continued hill selection, several strains of peanuts which have been segregated yielded more than 2½ tons of hay and approximately 1,600 pounds of shelled peanuts per acre. Some of these strains are yielding from 75 to 81 per cent shelled peanuts.

Peanuts for seed have been held in cold storage at 32° and at 40° F. and at room temperature, both shelled and in the pod. The average results with the principal varieties held for seed are consistent in that larger yields of both hay and peanuts are obtained when the seed is held unshelled. There are no very significant differences, however, with respect to the temperature influence on the seed. A test of peanut seed to show the effect, if any, of age gave results which indicate that peanuts retain their viability for at least five years, seed held for five years giving practically as good results as comparable seed from intervening years including that which was of the preceding season's crop.

From a utilization standpoint, peanuts for the making of peanut butter represent an industry of considerable importance. Serious difficulties commonly experienced in the handling of peanut butter on the store shelves are that in a comparatively short time rancidity develops and the oil separates and comes to the surface. Peanut butter made experimentally, packed in the sanitary type of tin can and given a mild processing under pressure, has kept in perfect condition with no loss of flavor and no rancidity for at least three years. Similar results follow the processing under pressure of peanut butter packed in glass containers.

POTATOES

CULTURAL EXPERIMENTS

Investigations at the Colorado Potato Experiment Station, Greeley, Colo. on the irrigation of the potato crop, particularly with respect to the time of the initial irrigation, have given results which indicate that a modification of the usual practice in the region should be made. It appears that a thorough irrigation earlier in the season after planting than is commonly done would be productive of better results than the usual practice.

The spacing experiments of the seed pieces with respect to the distance apart in the row have been rather conclusive. The spacing was from 8 to 14 inches at 2-inch intervals. The plots where the spacing was 14 inches in the row produced, as in the past, the heaviest percentage of cull stock. Closer spacing appears preferable.

Studies on the effect of different storage temperatures on potato seed stock, as well as on the methods of handling seed after it is cut for planting, are being conducted.

A good deal of attention is being given to seed selection and improvement. Many tests of certified potato seed have shown regularly that there

is a very wide variation in the productiveness of different strains of the same variety as well as in the relative freedom of certified seed from disease. The results of the tests emphasize the urgent need of more attention being given to the seed-stock problem.

The potato breeding work has been continued along the same lines as before. Of the 30,000 to 40,000 seedlings grown in connection with the breeding work between 1910 and 1912, none now remain. Beginning with the work in 1913, but one seedling of that year remains for further trial. Six seedlings were saved for planting in 1927 from the 9 that remained in 1926 from the seedlings of 1921. About 4,000 seedlings were grown for the first time in 1926. These resulted from crosses made in 1925. Of these 4,000 seedlings less than 300 were selected for planting in 1927. This indicates a very heavy elimination of seedlings that result from the crossing, but this is in entire accord with usual results of breeding work in any field. Only a very small proportion of the seedlings prove superior to the parents. As the work progresses the improvement that is accomplished in seedlings retained from year to year for further testing and which represent advancement in some lines will become available for use as parents in further breeding.

In the systematic work a problem of varietal identity was straightened out during the year. It was determined beyond doubt that the variety known as Perfect Peach Blow, the origin and history of which were obscure, was in fact the Adirondack variety, the history of which is a matter of record. The results of misnaming or renaming varieties frequently prove serious.

VIRUS DISEASES

Infection tests with mild mosaic, rugose mosaic, leaf roll, and spindle tuber on some of the important commercial varieties of potatoes and several of the most promising seedlings developed by the bureau disclosed that none of the varieties or seedlings tested is immune to all of these diseases. However, considerable variation in susceptibility, especially to mild mosaic and spindle tuber, was obtained. The Irish Cobbler variety has not manifested mild mosaic symptoms so characteristic for the Green Mountain variety. Similar responses to mild mosaic have been noted with some of the seedlings. This is a distinct contrast to the symptoms—more aggravated regarding mottling and leaf distortions than in mild mosaic Green Mountain—which are manifest on the very susceptible seedlings.

Tuber unit isolated seed plots for the control of virus diseases have been continued in northern Maine. Although complete elimination of all virus diseases has not been attained with these plots, it has been possible to reduce some of the diseases to a low percentage. In some instances the spindle-tuber disease has been practically eliminated by careful field inspection and roguing such plots during four seasons. Reductions in spindle tuber from 22 to 2 per cent have been obtained as a result of roguing such plots for a single season, whereas with the former bin-selection methods, growers rarely succeeded in materially reducing the percentage of diseased stock, so that it was not uncommon to find fields with 30 to 40 per cent of spindle tuber. Comparative studies on yield in different regions indicate that the deteriorating effects from the virus diseases are more severe in southern localities than in Maine.

The question whether the occurrence of sprout tubers, i. e., new tubers formed directly on the mother tuber before leafy shoots develop, is primarily the result of infection with a virus disease or of certain combinations of storage and planting conditions was raised by recent work in the Netherlands and in America. In an attempt to elucidate the rôle of these factors by storing potatoes from lots known to be nearly free from virus infection at various temperatures from 40° to 60° F., and planting them in soil of low moisture content at temperatures from 36° to 70°, the effect of environmental conditions outweighed that of possible virus contamination. Warm storage (60° F.) develops a tendency to sprout-tuber formation, which the planting conditions may or may not bring to expression, but the planting conditions may of themselves produce this result in the absence of an induced tendency. A strong tendency to sprout-tuber formation may persist even under normally favorable planting conditions. Sprout tubers were observed in a number of varieties, but could be induced by storage or planting conditions more readily in the Green Mountain variety than in the Irish Cobbler. This, however, is not a common form of sprouting abnormality in American potato culture. When it has occurred in the field it has been apparently

traceable to the conditions under which the seed tubers matured more often than to the storage or planting environment.

SWEET POTATOES

Comparative tests of seed stocks of certain standard varieties of sweet potatoes, including good commercial stocks and selections made in the course of the bureau's work, have demonstrated the superiority of some selections over others, the difference in yield in some cases being as much as 25 per cent in favor of the carefully selected strains of the bureau's stock. These studies have demonstrated the practicability of materially increasing the yield of sweet-potato varieties through an adequate selection of seed stock.

A study of the fertilizer requirements of the sweet potato has been made on the Portsmouth sandy loam and Norfolk sandy loam, respectively, in the vicinity of New Bern and Beaufort, on Norfolk loamy sand in Currituck County, and on Cecil sandy loam in Catawba County, N. C., with the object of determining the best ratio of phosphate, potash, and nitrogen economically suitable for the production of this crop. The study involves also the determination of the most profitable quantity of fertilizer to use and the kind of plant-food carriers best adapted to the crop. The experiments were similar to those carried on previously with potatoes in the same regions, where tests showed the fertilizer formulas best suited for that crop. The result is that the farmers in these places have been able to use a fertilizer of much cheaper composition than formerly. The experiment showed that potatoes had a lower potash requirement than the former practice in the region indicated, and the results with sweet potatoes show clearly a higher potash and a lower nitrogen requirement.

TOMATOES

FERTILIZER EXPERIMENTS

Among the special soil problems which required study in the laboratory, greenhouse, and field was one connected with the growing of tomatoes in the calcareous glade soil in Dade County, Fla. The work has demonstrated that at least one factor in the low fertility of these soils in relation to tomato culture is a deficiency of manganese. Pot experiments have shown a remarkable response to applications of soluble manganese salts, permitting normal growth and development which does not take place on the untreated soil, even with heavy applications of inorganic fertilizers. Practical field tests have confirmed these results.

LEAF SPOT AND EARLY BLIGHT

Good control of Septoria leaf spot and early blight has been obtained in experiments by means of fall plowing, much better, in fact, than by spraying or dusting. By the use of a plow with a well-curved moldboard and a rolling colter, jointer, and chain (standard weed-covering equipment), all trash or crop remains can be turned into the bottom of the furrow and thoroughly buried, which is essential for the most effective results. As plowing with this outfit requires no previous disking to cut the trash, it is a simple and economical field practice.

Excellent control of tomato blights has also been obtained by fall plowing, even when tomatoes grown on fall-plowed land were separated by a distance of only 270 feet from badly-blighted tomatoes grown on spring-plowed land; in fact, there was very little if any spread of the disease from the spring-plowed to the fall-plowed areas. Moreover, in all the experiments the infection in the fall-plowed plots has appeared chiefly on a few plants and has spread very little to adjacent plants. These facts indicate that a grower can obtain considerable control of these blights by means of fall plowing even though his neighbors may practice only the ordinary methods.

WILT

Seed of the new wilt-resistant varieties of tomato, Marvana, Marvelosa, and Marglobe, has been distributed to growers in shipping and canning regions for field trials and to seedsmen for tests and seed production. As a result the Marglobe is now grown almost exclusively in southeastern Florida and is being grown extensively for table fruit in New Jersey, Maryland, and parts of the Middle West, and to some extent in all of the principal shipping regions of the United States, as well as in Porto Rico and the Sinaloa district of Mexico.

WESTERN YELLOW BLIGHT

During the year there was a severe outbreak of western yellow blight in the Northwest generally, also in Utah, and to a slight degree in the Middle

West (Iowa). Field experiments were made along two main lines, fertilizer tests at Riverside, Calif., and shading experiments at Shafter, Calif., the object being to determine the possibilities of controlling the disease or at least appreciably reducing the damage caused by it. The percentage of blight on the Riverside plots was rather small, consequently the results of the fertilizer trials are not conclusive. The shading experiments at Shafter, on the other hand, gave a striking indication of the practicability of this method of protection. In order to make the method as economical as possible, several agricultural crops were tested as shade cultures, namely, sunflower, cotton, sesbania, and milo; but owing to a very slow growth early in the season of the three last mentioned, no shade was obtained before the blight appeared and consequently they were of no value as protective crops. The sunflower, on the contrary, grew very rapidly, and the tomato plants were well shaded during the blight period. Every one of the unprotected check plants blighted by June 24, while only 42 per cent of the plants growing between the sunflower rows blighted. There was an increase of only 4 per cent in blight in this group during the remainder of the summer, so that more than 50 per cent of the crop was saved.

During the second part of the summer rather unusual developments took place in the Northwest, particularly in the Willamette Valley, Oreg. Not only was the western yellow blight severe, but curly top of beets was equally prevalent, and a great number of other truck crops were also affected in a manner similar to these two diseases. This circumstantial evidence, coupled with inoculation experiments, indicates that all these troubles were caused by the curly-top virus. In the greenhouse at Riverside several series of inoculation experiments with tomatoes were conducted, using virus obtained from beets affected with curly top. The tomatoes became diseased very readily.

CEREALS

CORN

BREEDING

Of the 500 entries in the 1926 Iowa corn-yield test in which the Bureau of Plant Industry is cooperating, 367 were of open-pollinated strains and 133 were F_1 hybrids between selfed lines. The average yield of the hybrid entries exceeded that of the open-pollinated series in 12 of the 13 districts, the average excess of all of the hybrids being 4.5 bushels per acre, or more than 10 per cent of the average acre yield in Iowa.

An interesting variation has appeared in the self-pollinated lines in experiments in breeding pop corn. A certain row produced three selfed ears from which the popped kernels are all practically spherical in shape. A tendency toward this behavior in various degrees has been noted previously, but this is the first time the character has appeared homozygous in a line. Popped kernels of this shape are a novelty and might be of value in the manufacture of confections. More must be learned of the inheritance of this characteristic, however, before it can be made available commercially.

Waxy endosperm, in which the starch is replaced by erythrodextrin, has been combined with the large seeds and other characters of two commercial varieties of corn. It is believed that this new type of starch will find some special use, but before its possibilities could be tested it was necessary to transfer the characters from the small-seeded pop corn, in which it originated, to a commercial type of corn. Adequate waxy seed stocks, of both white and yellow dent, are now available.

By repeated back crossings of sweet corn and southern field varieties of maize, limited seed stocks are now available of varieties possessing all the characteristics of the original field varieties but with sweet seeds.

Through a cooperative arrangement with the Indian Office a collection of the varieties of maize grown by the Indian tribes has been brought together. In addition to establishing a collection of representative ears it is planned to maintain a living collection of these aboriginal types. The present collection is representative of 22 tribes and comprises about 75 distinct varieties.

DISEASES

Experiments have shown that an important cause of the resistance of some corn to smut is the manner in which the young tissues of the growing plants are protected from infection by the interposition of more mature tissue which excludes the smut organism. Strains of corn with well-developed husks have fewer smutted ears than strains with husks less well developed. These results are important in indicating the nature of re-

sistance to smut and in determining the characteristics to consider in selecting smut-resistant corn.

Cornstalks infected with *Ustilago zeae* have a lower sugar content than normal healthy stalks. The sucrose concentration is reduced to a greater extent than is the glucose concentration. These results contribute to the meager knowledge of the mode of nutrition of the smut organism and have a possible practical bearing in that they indicate a lessened food value of infected plants when used for fodder.

Experiments with seed infected with Diplodia and Gibberella, planted on soil with and without phosphates and manure, indicate that there was less seedling blight on plants in the soil that had received the phosphates and manure than on those in the untreated plots, but the ear rots seem to be more abundant where the fertilizer had been applied. The explanation for this reaction is not yet evident. The indications are that nearly disease-free seed is not benefited by seed treatment, but that it is distinctly advantageous to treat seed that carries infections with Diplodia or Gibberella to any considerable extent.

FLAX

In 124 samples of flaxseed, representing many varieties and strains of seed and fiber flaxes, the size of seeds ranged from 3.85 to 8.6 grams per 1,000 seeds and the yield of oil from 36.85 to 46.61 per cent. The correlation was 0.696 ± 0.031, showing a high degree of correlation between size of seeds and yield of oil. This explains why the linseed crushers are willing to pay a premium for the larger seeded flax of the so-called Russian type which is still grown to some extent in western North Dakota and Montana. Unfortunately, this type is not wilt resistant and can not be grown on the wilt-infested soils of older farming regions.

The extensive experiments which were begun in 1923, according to a more or less uniform plan prepared by the bureau and the State agricultural experiment stations of North Dakota, Montana, Minnesota, and Wisconsin, to test the value of mixed cropping of flax with wheat, oats, and barley, were completed with the crop of 1926. In the drier area, mixed cropping has been fairly effective in controlling the growth of weeds, especially of Russian thistle, as compared with flax grown alone. The yields of flax in mixture have not been satisfactory, however, and the practice can not be recommended for dry-land farming. In the more humid area the practice has been more successful. The relative yields of the mixed crops have generally been somewhat higher than those of flax and wheat grown separately, and there has been a marked control in the growth of weeds as compared with flax grown alone. But mixed cropping has not become popular in North Dakota, South Dakota, or Wisconsin. The somewhat greater cost of seed and the expense and trouble of separating the two grains after threshing and before marketing are rather serious disadvantages where the crop is grown on a large scale.

OATS

NEW VARIETIES

In addition to the four oat varieties, Albion (Iowa No. 103), Richland (Iowa No. 105), Iowar, and Iogren, which were developed in the cooperative experiments at the Iowa Agricultural Experiment Station, and which now have become standard varieties in the Corn Belt, a fifth new strain has been developed and recently named Iogold. It was distributed to farmers in the spring of 1927. It is equal to Richland in yield and rust resistance and similar in varietal characteristics, but has the additional advantage of being about 3 inches taller. On the more hilly land and thinner soils of Iowa, Richland has been too short for convenient harvesting. Iogold has been bred primarily to replace Richland under these conditions.

All of the new varieties developed cooperatively at Cornell University, viz, Comewell, Cornellian, Empire, Ithacan, Standwell, and Upright, are increasing rapidly in New York State. It is estimated that 200,000 acres of these varieties were grown in 1926, and the indications are that there will be another increase in 1927.

CROWN RUST AND STEM RUST

Preliminary experiments on the control of crown rust and stem rust of oats by dusting with sulphur were carried on at Ames, Iowa, during the crop season of 1926. A series of 10 plots of oats received a treatment of 10 to 20 pounds of sulphur per acre from one to three times a week. Both morning and evening applications of dust were made in order to determine the most satisfactory time of application. All applications were discontinued July 20, when the rusts

had become abundant and widely distributed throughout all the untreated plots.

Crown rust was controlled by three applications a week of 20 pounds of sulphur per acre. Ten pounds per acre, three times a week, gave almost equally satisfactory control. Applications of 10 or 20 pounds of sulphur twice a week reduced only slightly the quantity of rust and the severity of infection. The application of sulphur in the evening was more effective than that in the morning, probably because of the presence of dew, which served to hold the sulphur in suspension throughout the night.

In the control of stem rust of oats it was found that an application of 20 pounds an acre three times a week resulted in a more complete control than 10 pounds to the acre. No constant differences were observed between plots treated in the morning and those treated in the evening, when the number of applications and the quantity of dust were the same.

RICE

The question of the profitable use of fertilizers on rice in California is very important. Preliminary experiments are under way. In the fertilizer experiments with Caloro rice, the highest average acre yield was obtained from the plot fertilized with ammonium sulphate at the rate of 200 pounds to the acre, but the most profitable rate was 150 pounds per acre. All early-maturing rices, except Sue Hero, fertilized with ammonium sulphate at the rate of 150 pounds per acre gave marked and profitable increases in yields.

In the fall of 1925 early-maturing rice varieties were procured from the Orient for testing in California, where the present standard varieties sometimes are caught by early fall rains. A total of 1,126 varieties and selections were obtained. Their sources were as follows: Japan, 679; Chosen, 65; China, 180; Java, 123; the Philippine Islands, 77; and the Hawaiian Islands, 3. These rices were grown under detention in 1926 on an isolated farm near Shafter in the San Joaquin Valley. Adequate disinfection, fencing, and inspection insured that no diseases were introduced or spread. In spite of ocean transportation and subsequent disinfection, nearly all germinated. Lack of sufficient water and consequent luxuriant development of water grass prevented normal growth. However, disease-free seed of all selections, except the late-maturing ones from the Tropics, was obtained and will be grown at the Biggs station during 1927. The earliest strains from northern Japan matured in 98 days from first irrigation, which immediately followed seeding. Many strains from Chosen (Korea) matured in about 104 days. It is believed that desirable material for California conditions can be selected from these introductions.

SORGHUMS

Experiments show that early varieties of grain sorghum should be sown at rather late dates for best results, but that late varieties should be sown early. Many failures to obtain satisfactory stands of feterita by farmers probably have been due to planting before the soil is sufficiently warm and without treating the seed with fungicides.

Several strains of Straightneck milo, which are practically equal in yield to Dwarf milo, have been developed by hybridization at Woodward, Okla. These new strains are of short stature with erect heads and are well adapted to machine harvesting. Some of these strains have been backcrossed with the Dwarf milo parent to improve the kernel type and still retain the dwarf, erect habit of growth. These strains are earlier than the commercial Straightneck milos and should be better adapted to short and dry seasons, which frequently occur in the grain-sorghum region.

Loose kernel smut (*Sphacelotheca cruenta*) apparently was observed for the first time in feterita at San Antonio, Tex., in 1926. Smut appeared in the heads of the second growth only, no smut having been observed in the first crop which was harvested for grain in July.

Studies of the methods of harvesting grain sorghums were made in southwestern Kansas and western Oklahoma in cooperation with the Bureaus of Agricultural Economics and Public Roads and with the Kansas and Oklahoma experiment stations during the fall of 1926. Heading the grain sorghums by hand is the most popular method in that section. Combine harvesters have been used on the grain sorghums only in recent years. About 75 farmers who used the combine for this purpose were located and interviewed in the two States mentioned. The combine proved to be much more wasteful than other methods of harvesting, as determined by counts of heads left in the field after harvest,

but the work was accomplished with less labor. The Dawn kafir, which was developed and distributed from the United States Cereal Field Station at Amarillo, Tex., proved to be the variety best adapted for harvesting with the combine because of its short uniform stature which tended to decrease harvesting losses.

WHEAT

NEW VARIETIES

Two new rust-resistant hard red spring wheats, Ceres and Reliance, first distributed for commercial growing in 1926, have shown much promise. Ceres is a selection from a Marquis-Kota cross developed by the North Dakota Agricultural Experiment Station. It is nearly as rust resistant as Kota and outyields both Kota and Marquis even when rust or lodging are not limiting factors. Its milling and baking qualities also are equal or superior to those of the parent varieties. Reliance was produced by the department from a Kanred-Marquis cross. It is a true spring wheat. Although it has the rust resistance of the Kanred parent, its resistance apparently is not to the forms of stem rust that occur in the spring-wheat area. However, Reliance has shown greater resistance than Marquis. It is a vigorous, heavily tillering wheat, which accounts for its high yields in western North Dakota and in Montana, where it appears to be best adapted.

The standard varieties of durum wheat, Kubanka and Arnautka, were not so severely damaged from "root rot" as in previous years but did not outyield the best hard red spring wheats in 1926, even though it was a very dry year. The new productions, Nodak and Mondak, selected from Kubanka, continued to give good results in the sections where they were found to be best adapted. Nodak is rust resistant and for several years has been distributed in North Dakota from the Dickinson substation. Mondak is not resistant, but it is early, stiff-strawed, and of high quality for the manufacture of macaroni. It has been distributed in western North Dakota, and in 1926 it was increased at Montana stations for distribution in 1927. Several promising new hybrids of Kubanka No. 8 × Pentad and Mindum × Pentad were produced to combine the rust resistance of Pentad with the good quality of the other varieties.

A smut-resistant selection of Turkey, developed cooperatively with the Oregon station, was named Regal, and about 300 bushels were distributed for commercial growing from the Sherman County branch station in the fall of 1926. This new hard red winter wheat has purple stems, which enable it to be identified.

The Federation and Hard Federation spring wheat varieties have been grown extensively in Oregon since 1925, where they were used largely to replace winter-killed hard red winter wheat. The Federation variety now is extensively grown in the milder sections from fall seeding, although it is a spring wheat, and is grown from spring sowing under irrigation in Oregon, Idaho, and Montana. A white-kerneled, soft winter wheat, White Odessa, has proved to be smut resistant and a high yielder in Oregon and Washington. Onas, a soft white wheat introduced by the department from Australia, is becoming widely grown in California since its first distribution from the Davis station in 1923.

STUDIES ON HARVESTING

Studies of the efficiency of the combined harvester-thresher for harvesting and threshing wheat in Oklahoma, Kansas, Nebraska, and Montana were conducted during the summer of 1926 in cooperation with the Bureau of Agricultural Economics and the Bureau of Public Roads and the Oklahoma, Nebraska, and Montana State experiment stations. Harvesting losses were estimated in 259 fields cut by combines, 59 cut by headers, and 34 cut by binders. The harvesting losses were least in fields cut by the combine and greatest in fields cut by binders. The average harvesting loss shown by 190 combines cutting hard winter wheat was 2.63 per cent. Under the same conditions the headers showed an average loss of 3.27 per cent and the binders 6.06 per cent. The hard red winter and hard red spring varieties grown in the sections where the harvesting studies were made are well adapted to the use of combines because they are not very susceptible to shattering. Practically no shattering was observed during the season of 1926 except in fields which showed severe hail injury.

FLAG SMUT

Experiments on flag smut of wheat were begun at Granite City, Ill., in 1919, the year in which the disease was first recognized in the United

States, and have continued without interruption until this year. With the end of the 1926 season the work at Granite City was brought to a close. The results of these investigations may be summarized as follows:

Spores of the causal organism, *Urocystis tritici*, have been found to live a full year in infested straw buried in the soil, and then to cause infection of wheat.

Infection of wheat by flag-smut spores on the seed can be prevented by seed disinfectants, including copper carbonate and other dusts, but they do not control the disease satisfactorily if the soil is infested.

Numerous varieties and strains of wheat have been included in these experiments, and their reaction toward flag smut has been determined. Many of these wheats proved either highly resistant to or free from flag smut. Among these are several varieties of soft red winter wheat adapted generally to the flag-smut area. The hard red winter wheats as a class are highly resistant, and several varieties have proved to be immune. Several varieties of white wheat have been immune in these experiments, but several of the most important varieties of white wheat have winterkilled before their reaction was determined. Possibility of control on the Pacific coast by means of resistant varieties still is in doubt. It has been possible to isolate apparently resistant strains by selection in Harvest Queen, a well-adapted but highly susceptible variety.

SCAB

Field, greenhouse, and laboratory investigations have been conducted to determine the relative susceptibility of numerous wheat varieties to scab. All varieties tested have been found susceptible when the environment is such as to favor the development of the disease either in the seedling stage or at heading time. The three selections of Turkey wheat that previously have shown resistance continued to show resistance both to seedling blight and head infection when grown under general field conditions, but all three proved susceptible when grown under artificial conditions where temperature and humidity were favorable for infection immediately following artificial inoculation. Therefore, indications are that resistance in these cases is only relative.

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STEM RUST

The weather during the fall and winter of 1925–26 favored overwintering of stem rust in Texas, Oklahoma, and Colorado but not elsewhere. Early spring weather favored the development of rusts on small grain in the winter-wheat area. The May drought in the spring-wheat area, followed by cool weather in June and July, checked the development of rust. Barberry infection was delayed during the latter part of April by drought in northern Kansas and Missouri and southeastern Nebraska, and by cool weather in Indiana and Ohio. The temperature throughout the spring-wheat area was below normal during May, June, and July. This, accompanied by droughty conditions throughout that area, tended to delay the development of stem rust. It is probable, in view of all the conditions under which the belated and rather mild epidemic developed, that barberries were responsible for much of the rust in the Eastern States and contributed materially to what occurred in the spring-wheat area by furnishing much of the initial inoculum for the primary infection centers of this latter area.

An investigation of the value of sulphur dust as a preventive of stem rust of wheat brought out the following outstanding results:

(1) Under certain conditions sulphur dust will control stem rust even in the presence of a severe natural epidemic.

(2) In the Crookston (Minn.) experiments three or more dustings at the rate of 150 pounds per acre per application controlled the rust. Two dustings greatly reduced the quantity of rust and delayed its appearance. One dusting delayed the appearance of the rust.

(3) The most satisfactory interval between dustings appears to be from 5 to 7 days. Applications at weekly intervals apparently control stem rust as effectively as do those of 4-day intervals. Even applications at 11-day intervals controlled rust satisfactorily, though more evidence is needed to show that applications made at such wide intervals will consistently control the disease.

BARBERRY ERADICATION

In the nine years that the barberry-eradication campaign has been in progress more than 14,300,000 plants

of common barberry have been eradicated. The removal of these bushes has aided materially in reducing stem-rust losses of small grains. In the eastern States of the barberry-eradication area obvious control of local epidemics of stem rust has resulted from the removal of harmful barberries.

Three surveys are in progress. These are (1) the original or first survey, (2) the second survey, and (3) the resurveys. The first survey is almost completed. Almost 863 of the 920 counties necessary to survey have been covered. The second or more intensive survey is in progress and about 200 counties have been covered. Resurvey for eliminating sprouts and seedlings after the first and second surveys is somewhat continuous. Portions of some counties covered by the second survey have been checked for overlooked bushes and seedlings developing since the second survey. It is apparent that additional surveys of some areas will be necessary.

Salt is recommended for use in killing barberries. Kerosene is used if more convenient to procure, or if the salt may be disturbed or eaten by animals. However, the action of kerosene is very slow. Barberry bushes close to valuable plants or trees are dug or pulled, as the application of chemicals may damage the other plants. Seedlings and small bushes sometimes are pulled, as it often is more economical to do this than to treat them with chemicals. That chemical eradication is effective is shown by the few sprouts that develop where chemicals have been applied properly.

NITROGEN COMPOUNDS

Investigations on nitrogen compounds of cereals have shown that rice and rye have respectively the lowest and highest proportions of amino nitrogen, and that between them are wheat, oats, and corn, in which, in the order named, the proportion of amino nitrogen, calculated on the basis of the oven-dried kernel and of the total nitrogen of the oven-dried kernel, gradually increases. It is also found that rice and rye have respectively the lowest and highest percentages of peptide nitrogen, but that between the two are corn, oats, and wheat, in which, in the order named, the peptide nitrogen, calculated to the oven-dried kernel and to the total nitrogen of the oven-dried kernel, increases.

During the first two or three days of seed germination some soluble, diffusible, and readily transportable material is needed for building up the tissues of the young plantlet. The nonproteins contained in the seed represent such material. As soon, however, as chlorophyll appears and the enzymes are coming into play, the plantlet is, of course, able to synthesize carbohydrates and to split the stored-up seed proteins, which are mostly insoluble and at any rate not diffusible, into smaller molecules (amino acids, acid amides, etc.), which can then be readily transported to the growing parts of the seedlings. The polypeptides, standing as they do between the amino acids on the one hand and the proteins on the other, may be split by the enzymes present into amino acids for translocation to points where they are needed, or they may represent the immediate material out of which the great protein structures are synthesized.

SUGAR PLANTS

SUGAR BEETS

Investigations of sugar-beet diseases were carried on at four field stations. A study of the Cercospera leaf spot and its control was made at Rocky Ford, Colo., of curly top at Las Cruces, N. Mex., and Riverside, Calif., and of damping-off of beet seedlings, root rots in the field, and decay of sugar beets in storage at Logan, Utah.

At Riverside, Calif., a careful study of the relation of light, temperature, and humidity to infection of sugar beets by curly top indicated clearly that temperature is the most important external factor influencing the incubation period of the disease. The amount of virus injected was evidently correlated with the probability of infection, and also to a detectable degree with the length of the incubation period. This points out that the amount of disease and severity of damage are correlated with the abundance of insect vectors, *Eutettix tenella*. Work on selection of individual plants for resistance to curly top demonstrated that some of the selected strains are highly resistant and that this characteristic persists under widely different soil and climatic conditions.

At Fort Collins, Colo., 56 of the 506 strains tested were found to be superior to the check in sugar production, and 8 were decidedly resistant to leaf spot. A few more exacting trials appear to be all that is necessary to justify placing several of our beet

strains upon the market as decidedly superior to commercial varieties in sugar production and in leaf-spot and curly-top resistance.

At State College, N. Mex., data on beet-seed production indicated that yields of from 1,500 to 3,000 pounds per acre of drapered seed of good quality could be obtained by overwintering late-planted beets and harvesting the seed in July, a method devised by the bureau. It is estimated that beet seed can be produced in that way at much less than half the cost required in biennial seed production.

The fertilizer investigations with sugar beets which were begun a few years ago because of emergency problems existing in the Arkansas River Valley have lately been extended not only to other soil types in this valley but to other regions, notably the San Luis Valley of Colorado, the Salt Lake district of Utah, the Platte River Valley in Nebraska, the Red River Valley of Minnesota and North Dakota, and also central and southern Minnesota and points in Iowa and Michigan. Both irrigated and nonirrigated districts are included. As a result of recommendations made from these experiments, several carloads of fertilizer were distributed in States where no commercial fertilizer had previously been used.

SUGAR CANE

Sugar-cane disease studies were conducted at three field stations and at Washington.

At Houma, La., work on the injurious factors or agents responsible for the widespread damage to sugar-cane roots was carried on, together with investigations of control measures.

At Canal Point, Fla., a research project on sugar-cane seedling diseases was started, and results have been obtained indicating that control of seedling diseases can be effected by drenching the soil in seed flats with formalin. Despite the destructive hurricane in September and the subsequent floods, more than 10,000 new seedlings were produced at Canal Point, many of these being hybrids resulting from desirable crosses. Field tests under average plantation conditions in Louisiana with 11 of the newly imported P. O. J. varieties of sugar cane again indicated the decided superiority of Nos. 234, 213, and 36 over the old "native cane." These varieties, which were recommended by the bureau in 1924 and 1925, were extended to include 23,000 acres of commercial cane in the fall of 1926. P. O. J. 234 as well as 213 outyielded the "native cane" in the least severely diseased areas of the sugar belt by 300 to 800 pounds available sugar per acre. In the more severely diseased areas the difference was, of course, much greater. The prospect of still better performance of stubble crops in succeeding years is indicated by the results with these varieties. Experiments indicated that with the new varieties P. O. J. 36, 213, and 234 when windrowed after a freeze, the sucrose content diminishes rapidly, but if allowed to stand in the field for as much as six weeks there is usually no loss and in some cases a slight gain. This is an important observation of considerable practical value to the cane planters of Louisiana.

TOBACCO

REGIONAL EXPERIMENTS

In the Maryland tobacco investigations, with headquarters at Upper Marlboro, the extensive plot tests with nitrogen derived from several different sources and at varying rates of application were continued. It was found that increased nitrogen supply tends to impair the burning qualities of the leaf. An interesting result in these tests is that on some soils nitrate of soda as a source of nitrogen for tobacco gives satisfactory results only if the soil is limed. In the cropping tests superior results again were obtained with tobacco on rested land; that is, tobacco grown in rotation with weeds, as compared with tobacco in continuous culture or in rotation with legumes and other soil-improving crops. In particular, the quality of the cured leaf of the crop on rested land was markedly superior in burning qualities, texture, and color. The fire-holding capacity of the leaf was fully 10 times that of the leaf produced in continuous tobacco culture. Use of a highly concentrated fertilizer composed of ammonium phosphate and nitrate of potash has given unsatisfactory results on certain soils at Upper Marlboro and in other tobacco-growing districts unless the soil is limed. The leaves of the plant show definite pathological symptoms during the growth period, but when lime is applied to the soil the plant seems to grow normally.

In the flue-cured tobacco district, investigations were continued at Oxford, N. C., and Tifton, Ga. A leading feature of the work at both points is

an extensive series of fertilizer tests dealing with the sources and rates of application of nitrogen, phosphorus, potassium, magnesium, calcium, sulphur, and chlorine required for maximum yields of flue-cured tobacco and the production of leaf of the best quality. Results of importance are: (1) On some of the tobacco soils magnesia applied in suitable form greatly increases the quality and commercial value of the crop; (2) the quantities of potash commonly used in the fertilizer are not sufficient for best results; (3) the form of potash used has a marked effect on the crop, the forms rich in chlorine tending to increase the yield somewhat but having a decidedly injurious effect on the combustibility of the leaf. For the most part sulphate sulphur tends to depress the yield.

In the tobacco-disease work in Wisconsin special attention has been given to the virus diseases of tobacco and related plants. The results indicate that there are at least 11 different forms of mosaic which may attack tobacco, the distinction between forms being based on differences in symptoms manifested in tobacco and other "differential" hosts and on differences in the properties of the viruses. Among the properties of diagnostic value are longevity in vitro, thermal death point, and the lethal action of chemicals. It has been found that tobacco-mosaic virus can be attenuated, as is well known to be true of animal viruses. When freshly inoculated tobacco plants are maintained at a temperature of 35° C. for 10 days or more, transfers from these plants produce symptoms decidedly different from those caused by the original virus. Microscopic examination of the leaf tissues in the pole-sweat or shed-burn disease which occurs in the curing shed indicates that, contrary to prevailing theories, this disease is probably of a nonparasitic nature.

CALCIUM DEFICIENCY

In the work on plant nutrients the principal result was the development of clearly defined symptoms of calcium deficiency under field conditions when no calcium was supplied in the fertilizer. These symptoms may be obtained, for example, when a highly concentrated fertilizer, such as nitrate of potash and ammonium phosphate, is used. The symptoms as developed in the tobacco plant were quite distinctive and involved primarily the leaf. There was malformation of the leaf and development of ragged margins, but most striking was the failure of large areas of lamina to develop, large leaves thus appearing as if large sections had been cut away. Thus, calcium is shown to be one of the necessary constituents of the fertilizer for some soils.

EFFECT OF LIGHT PERIODS

The systematic planting of early, medium, and late varieties of soy beans in the field at fixed intervals through the season was again carried out to obtain data on length of day as a factor in the effect of date of planting on the length of the vegetative period. The field work dealing with the effects of crops on yields of other crops following in the rotation was continued at Upper Marlboro, Md., Bowling Green, Va., Timmonsville, S. C., and Tifton, Ga. As a whole the results supplement and support those previously obtained, which show that it is not possible from a knowledge of the general characteristics of a crop to predict its effect on soil productivity so far as concerns some other particular crop. At Tifton, Ga., however, such crops as tobacco, peanuts, and sweet potatoes grown in rotation gave some interesting interrelationships with respect to fertilizer effects. Where no phosphorus was applied in the rotation of sweet potatoes and tobacco the yield of sweet potatoes was relatively high, while the tobacco crop gave a very low yield. In the rotation of tobacco and peanuts, when potash was omitted from the fertilizer the tobacco suffered severely from potash hunger and the yield was very low, while the yield of peanuts under this treatment was relatively high.

DRUG AND OIL PLANTS

MENTHOL

It is desirable to establish a domestic supply of menthol, an important medicinal product, and thus remove the dependence of American consumers on the Japanese producers of the essential oil of *Mentha arvensis* var. *piperascens*, from which this product is obtained. Investigations which have been under way for several years seeking to establish Japanese mint as a crop in the United States have therefore been continued and further cultural data collected. Conclusive evidence has been obtained showing that this mint will not deteriorate in menthol content of the oil after several years' culture in this country, as had been con-

sidered probable. As in the preceding season, samples of oil produced in various sections of the country were procured through cooperators who were supplied with planting stock by the bureau. These oils contained a satisfactory amount of menthol, from which it is concluded that when grown in those sections, this mint yields an oil suitable for commercial menthol production.

SANTONIN

The supply in the United States of the important vermifuge santonin, obtained from Levant wormseed (*Artemisia cina*), has long been very restricted by the producers in Turkestan who control the production; consequently the cultivation of the plant in some of our Western States where conditions are favorable is much to be desired. In 1926 four-fifths of an acre was under cultivation on the bureau's farm at Hermiston, Oreg. This planting under irrigation yielded dried flower heads at the rate of 1,200 pounds per acre. Harvesting was delayed too long to insure the highest santonin content in this material, a portion of which was shipped to a pharmaceutical manufacturer for examination, but the experience gained should insure a crop of good quality next season. The plant also grows exceptionally well in the San Joaquin and Sacramento Valleys of California, but its introduction would be especially helpful as a money crop to the farmers in northeastern Oregon. The price of santonin at the present time greatly restricts its use as a vermifuge for hogs. An increase in the supply will no doubt reduce the price considerably, but veterinarians express the opinion that its use for dosing hogs will greatly increase as the price declines, thus indicating a considerable opportunity for American producers.

COTTONSEED OIL

The oil and protein value of cottonseed is of importance to the cotton-oil industry and the cotton grower. The adaptiveness of cotton varieties in any locality must depend primarily on their lint-producing qualities. It is recognized, however, that with the establishment of official grades for cottonseed it will benefit the grower to select varieties which in addition to possessing desirable lint-producing qualities also yield seed with a good oil and protein content. In order to obtain comprehensive data on the relationship of the oil and protein content of cottonseed to varieties and cultural conditions, analyses of seed representing about 30 varieties grown in several localities in cotton-producing areas over a period of years was undertaken at the request of the Interstate Cottonseed Crushers' Association in 1923. Three years' results indicate that certain varieties produce seed which is high in oil content as compared with the others irrespective of the point of production. It is also evident that to the same extent certain varieties produce seed low in oil content. Such tendencies in varieties when definitely known should be an important consideration in the breeding of new varieties and eventually should directly benefit the cotton planter and notably improve the raw material available for the cottonseed-oil industry.

HOP OIL

The production of hop oil from lupulin which accumulates as waste at certain stages in the harvesting of hops on the Pacific coast has apparently provided a new source of considerable income to hop growers. Investigations on the utilization of this waste as a source of hop oil were undertaken by the bureau several years ago when the increased demand for the oil and its future importance became evident. The oil has long been used in the flavoring of cereal beverages and more recently has been favorably received as an important agent in the preparation of certain perfumes.

TUNG OIL

Renewed interest has been aroused in the commercial planting of the tung-oil tree in this country. The tree furnishes an oil of high grade for varnishes and paints. Practically all of the oil is imported from China, the importations amounting to about $10,000,000 annually. Efforts are being made to establish plantations of the tree in Florida. About 1,300 acres have been put out, with a prospect of about 300 additional acres for this year. The bureau is assisting in this work in an advisory capacity, cooperating with the University of Florida at Gainesville.

ORNAMENTALS

BULBS

The field activities in bulb culture center in the United States Plant Introduction Gardens at Bellingham, Wash., and Chico, Calif., at the Ar-

lington Experiment Farm, Rosslyn, Va., and at the Coastal Plain Field Station of the North Carolina Department of Agriculture at Willard. An important development of the year was the installation at Bellingham of an improved bulb-sterilizing machine. Practicable and effective methods of treating bulbs, and investigations as to their limits of endurance of treatment with a view to freeing them of certain insects, have been inaugurated and are in progress.

Investigations carried on in cooperation with the Oregon Agricultural Experiment Station during the last year have shown that the gray disease of daffodils is an infectious mosaic and occurs to a greater or less extent in nearly all varieties. Affected plants are less vigorous, increase less rapidly, and produce flowers of inferior quality. The mosaic can be transmitted artificially by juice transfer, but no insect carriers are as yet known.

The modification in tulips known as "breaking" has also been demonstrated to be an infectious mosaic. Some "broken" tulips are prized as novelties, but for the most part they are inferior and undesirable. Since a widespread insect carrier is here concerned, growers should take immediate steps to eliminate broken varieties from their collections.

Questions heretofore have arisen in regard to the merit of domestically produced Dutch bulbs for forcing. Continued tests of bulbs grown at different places in the United States in comparison with imported bulbs have been exceedingly favorable to home-grown material. The results in the culture and handling of hyacinth and iris stocks have been such as to justify the statement that their production is practicable both in the Pacific Northwest and in the vicinity of the District of Columbia. Lily seed of different kinds has been brought together from all over the world where lilies grow, the planting at the present time occupying about a quarter of an acre. Additional data are being accumulated concerning the vegetative propagation of lilies. It has been determined that a hundredfold reproduction is possible in some species.

ROSES

In its range of possibilities and in the wide character of the selections under test, the work with rose stocks is perhaps fully as comprehensive as that of any other group of ornamentals under consideration. The stock which appears to give the most satisfactory results with some varieties may not hold the same relative position when used as a stock for some other varieties. It may be that several stocks having particular affinities with different varieties and showing different adaptations to soil, moisture, and temperature conditions will be required to meet the demands of the rose trade.

FORAGE CROPS

ALFALFA

IMPORTED AND DOMESTIC SEED

It has been recognized for some time that success in growing alfalfa depends in large measure upon the seed that is used. The fact that failures of alfalfa were reported more and more frequently and had recently been reported from such an old alfalfa section as Kansas made the study of the value of the various strains of the utmost importance. As a whole, seed from foreign sources has given unsatisfactory results in the United States, particularly in the region east of the Iowa-Nebraska boundary and north of the southern boundaries of Virginia, Kentucky, and Missouri. This region, with an annual seed requirement estimated at approximately 12,000,000 pounds to maintain the present acreage, produces very little seed and therefore must depend upon outside sources of supply. In the Southeastern States, that is, the region south of Virginia, Kentucky, and Missouri and east of the Texas-Louisiana line, alfalfa is relatively unimportant, the annual seed requirement being less than 750,000 pounds. For the entire area west of the western boundary of the tier of States from Minnesota to Louisiana, the annual seed requirement is estimated at 20,000,000 to 24,000,000 pounds, all of which is produced in the region and in addition a considerable surplus.

The interest in this problem resulted in the passage of an amendment to the Federal seed act, requiring the staining of imported alfalfa and red-clover seed to indicate origin and unadaptability. For further discussion of this act and amendment see page 25.

WINTER INJURY AND WILT

At the beginning of the growing season a large number of complaints were received from farmers to the effect

that much of their alfalfa which had gone into the winter in excellent condition was either dead or dying and that the fields were no longer worth maintaining. Several trips were made to different parts of Kansas, Oklahoma, and later to Missouri, to determine the cause of the trouble, which proved to be due largely to winter injury, in many cases followed by bacterial wilt caused by *Aplanobacter insidiosum*. Frequently the plants were not killed outright but were greatly injured, various types of lesions being produced in the taproots at or just below the crown.

The bacterial wilt was discovered in eastern Mississippi, where it may have been a factor in alfalfa failures in the past. It had been found previously in the western part of the State. This relatively new disease, caused by *A. insidiosum* has appeared to be rather serious, particularly in some of the most important alfalfa-growing States, such as Kansas, Nebraska, and Oklahoma. At present the most hopeful solution appears to be through the discovery or development of a variety that is more or less resistant to the disease.

STEM NEMATODES

During field excursions the past season the presence of the stem nematode was discovered in one alfalfa field in Oklahoma and four fields in Kansas, in all of which it appeared to be causing considerable damage. So far as known, this was the first discovery of the pest in Oklahoma. It had been found in Kansas a number of years ago, but had not since been seen in the State until recently. In all cases county agents and other State and Federal officials were informed of the presence of the pest, so that adequate measures for its control could be initiated.

CROWN WART

Crown wart, which is sometimes destructive in the States west of the Rocky Mountains, was found in several fields in Mississippi and Alabama, this being the second report of the trouble east of the Rocky Mountains. The disease, although very abundant in some fields, did not appear at the time to be causing much damage, although some stems were killed and the yield of the hay somewhat reduced.

STEM ROT

One of the troubles in Oregon with alfalfa, sweet clover, and red clover is stem rot, and for some years work has been carried on at the Oregon Agricultural Experiment Station looking toward the selection of a variety of alfalfa resistant to it. In 1922, 34 varieties and strains of alfalfa were seeded on land known to be infested with the disease. Each year since that time some plants have died, the largest loss being during the first year, indicating that the most susceptible plants were attacked first. During 1924 and 1925 there was a considerable decrease in the disease, and during 1926 no plants were killed. This would appear to indicate that the plants remaining on infested land after four years are at least highly if not entirely resistant. The different varieties varied widely in their resistance, the Grimm, Baltic, Chilean, Dakota 12, and South African strains being injured very little.

RED CLOVER

The extremely short crop of American-grown red-clover seed in 1925, followed by another equally short crop in 1926, has accentuated the interest in foreign and domestic red-clover seed. The passage of the act requiring the staining of seed has been mentioned. In June, 1926, as a result of hearings held in May of that year, the Secretary of Agriculture ordered that all red-clover seed from Italy must have 10 per cent of the seed stained red. Seed coming from Canada was ordered to be stained violet and that from other countries green.

All the information available indicates that red clover is going through a critical period in the United States. Seed production has fallen year by year in spite of the fact that prices have gone up. Some of this reduction is, without doubt, due to unusual weather conditions, but to a certain extent it is due to the fact that what clover is grown is used for other purposes than seed production.

Although exact information is lacking, it is strongly suspected that a part of the trouble may be found in the large importations of European red-clover seed during the last few years. Although the bureau has had no opportunity to conduct experiments on this point, observations made in the field indicate that imported red clovers, including the French, which in some parts of the country has given excellent results as a hay producer, do not produce good crops of seed in this country. The flower heads are smaller than heads of American clover and less well filled with seed. There is

reason to suspect that many farmers who have unknowingly used imported seed have not saved fields for seed because it was evident that the seed crop would not be worth while.

SWEET CLOVER

After five or six years of phenomenal expansion, the sweet-clover acreage in the United States appears to be approaching a position of stability and the crop may be definitely regarded as an established major legume. The exact extent of sweet-clover culture is not known, but from information furnished by seed dealers and from other sources it appears likely that the acreage exceeds that of cowpeas, possibly that of red clover and soy beans, and is exceeded only by alfalfa and timothy and clover mixed.

The most common difficulty in growing sweet clover, especially in semiarid regions, is failure to obtain a stand. Aside from lack of inoculation and lack of lime in the soil, both of which can readily be determined, no satisfactory explanation has been advanced for this condition. Acting on the belief that stand failures were due largely to faulty methods of planting, experiments were undertaken last year in which seed of different degrees of quick germination was planted at intervals throughout the year. At the end of the first year it is apparent that in many places the most reliable method of obtaining a stand is to sow unscarified or even unhulled seed in late fall or early winter. This imitates the natural method of sowing. With this method the hard seeds remain in the soil for several months, gradually absorb moisture, and appear to be in a position to germinate at the optimum time. Whatever the reason, the seedlings become well rooted before the soil becomes hot, the plants produce larger tops and roots the first year, they are better able to combat weeds, and there is a great reduction in the number of plants lost from heaving during the second winter. The contrast between plots planted in this manner and plots planted in the ordinary manner with scarified seed in April has been extraordinary at each of the five stations where this experiment was conducted in 1926.

SOY BEANS

The principal lines of work conducted with soy beans in 1926 were practically the same as in 1925, although upon a larger scale, due to increased interest in the crop. About 300 new introductions received from China, Japan, Manchuria, Chosen, and Java were tested for the first time. In the breeding work about 2,500 individual plant selections from previous introductions and standard varieties, representing more than 1,000 distinct sorts, were tested at forage-crop stations in Virginia, South Carolina, Ohio, Illinois, South Dakota, and Oregon. Extensive cooperative tests with new varieties developed by the bureau were carried on with 30 State experiment stations, and the same varieties were used in extension work with special cooperators in 40 States. Cooperative tests were also carried on with 12 foreign countries.

In the test of new introductions, the most promising were shown in the individual plant selections received as the result of agricultural exploration in Manchuria. Grown in Illinois, Virginia, Ohio, and Oregon, about 25 of these selections appeared to be very promising forage and grain varieties for the Central and Northern States.

Cooperative tests with experiment stations and special cooperators indicated the importance of varietal adaptation and that if suitable varieties are used the soy bean is of more or less value not only in the eastern half of the United States but also in sections of New Mexico, Arizona, California, and the Northwest. New varieties that gave excellent results in 1926 cooperative tests were Dixie, Old Dominion, Black Hilum Manchu, Chiquita, and George Washington. In extension work the early varieties Manchu, Mandarin, Black Eyebrow, Nea, Hoosier, Aksarben, Elton, Chestnut, Habaro, Pinpu, and Dunfield continued to be important factors in the increase of acreage in the Central States and in extending the area over which the soy bean has grown in the Northern States. In the Southern States the Biloxi and Laredo varieties increased in acreage and are becoming two of the most popular southern varieties. The Chiquita, due to its remarkable drought resistance, gave excellent results in eastern Oklahoma and New Mexico and has become an important factor in establishing the soy bean in those sections. Other varieties developed by the bureau and of importance in the soy-bean industry were Hahto, Southern Prolific, Lexington, Columbia, Sooty, Wilson-Five, and Virginia.

COWPEAS

The general lines of investigations conducted with cowpeas in previous

years were continued. Nearly 200 selections and introductions of *Vigna sinensis* (cowpea), *V. cylindrica* (Catjang cowpea), and *V. sesquipedalus* (Yardlong or Asparagus bean), received from China, Japan, South America, Java, and Africa, were tested in Virginia, South Carolina, Mississippi, and Oklahoma. The most promising of all introductions undoubtedly were four of *V. cylindrica* received from Egypt, of which sufficient seed was obtained for extensive tests in 1927.

In extension work and cooperative variety work the Columbia and Victor were outstanding in promise. The Victor proved not only especially promising as a general forage and grain variety in wilt and nematode soils, but gave the highest yields in summer cover trials in California. The Columbia and Arlington varieties also gave promising results as forage and grain varieties over a wide area. In the northern part of the cowpea region the Early Buff and Early Red were very promising.

ENFORCEMENT OF FEDERAL SEED ACT

SEED TESTING

In connection with the enforcement of the Federal seed act, all shipments of seed subject to the act are sampled by the United States customs service and are examined by the seed-testing laboratories of this bureau for mechanical purity, adulteration, and germination before the seed is permitted or prohibited entry into the United States.

Samples of 775 importations of forage-plant seeds not subject to the Federal seed act were received through the customs service. The greater part of these were tested, and when the seed was found to be of poor quality the importers were notified to that effect.

During the calendar year 1926 samples of approximately 2,295 lots of imported seeds were drawn by the customs service and submitted to the seed laboratories for examination. Of these, 85 lots, comprising 2,008,200 pounds, were prohibited entry under the act. Of this prohibited seed approximately 675,000 pounds was red clover and 770,000 crimson clover. Much of the rejected seed was recleaned to comply with the requirements of the act. More than 957,000 pounds, mostly crimson clover, was exported and 90,000 pounds of refuse destroyed.

STAINING IMPORTED SEED

The Federal seed act, as amended April 26, 1926, requires that all seed of alfalfa and red clover imported into the United States be stained indicating origin, and provides that if seed from any country or region is unadapted for general agricultural use in the United States at least 10 per cent of each lot imported be stained red. Accordingly, alfalfa seed from Turkestan and Africa and red-clover seed from Italy are stained 10 per cent red, and alfalfa seed from South America is stained 10 per cent orange red. Alfalfa and red-clover seed grown in Canada is stained 1 per cent iridescent violet, and alfalfa and red clover seed grown in all other countries is colored 1 per cent green. The coloring provision of the act has been supervised without increase in funds and is in successful operation. The staining of imported seed of alfalfa and red clover should result in an automatic agronomic test of the relative value of domestic and imported seed in regions where both are used.

MISBRANDED SEED

A further amendment (section 6) of the Federal seed act prohibits the transportation or sale in interstate commerce of seed which is misbranded. Misbranding will be considered in the act to include (1) any seed bearing any statement which is false or fraudulent either on the container or in the invoice or advertising; (2) imported seed of alfalfa or red clover which is not colored in accordance with the requirements of the Federal seed act; (3) seed colored in imitation of imported seed required to be colored under the Federal seed act.

The penalty for the shipment or sale in interstate commerce of misbranded seed is confiscation by process of libel for condemnation. It seems practicable to apply section 6 of the act only in cases of deliberate misrepresentation and not to attempt to apply it in cases where there is found to be an accidental deviation from guaranteed analysis. This amendment would appear to be most effective in preventing the sale of agricultural seeds which are misrepresented as to origin. The Department of Agriculture is ready to consider any case of deliberate misrepresentation brought to its attention with a view to action under section 6 of the Federal seed act.

FIBER PLANTS

COTTON

IMPROVEMENTS IN PRODUCTION

With generally favorable conditions in the season of 1926, the largest cotton crop in the history of the American cotton industry was produced. The adjustments that have taken place during the period of the weevil invasion are shown to be effective. A permanent restriction of the crop by the boll weevil is no longer to be feared, though a wide range of seasonal fluctuations must be expected. The varieties of cotton have been improved and cultural methods have been changed, so that the crop is better adapted to short seasons and to conditions of weevil infestation.

The organized communities of cotton growers have numerous advantages in maintaining supplies of pure seed, growing larger and more uniform crops, and marketing a standardized fiber in commercial quantities. Community production of one variety of cotton opens the way to a general improvement of the cotton industry not otherwise to be attained. To get the proper results it is necessary that the community interest reach the point of agreeing to make a sustained effort through a period of years. The bureau encourages such movements and gives such assistance and cooperation as it can to the districts that can establish community agreements for five years or more as the basis of a practical effort in community production.

The Acala variety, introduced by the bureau from southern Mexico several years ago, now forms the bulk of the cotton produced in the irrigated regions in California, Arizona, New Mexico, and western Texas, where a total of approximately a half million acres of this variety are being grown. Supplies of pure seed are available for other districts from communities that grow Acala cotton exclusively. The variety is adapted to a wide range of conditions in the eastern Cotton Belt and may be utilized to a great extent if the necessary supplies of pure seed are established and maintained.

Commercial production of Pima cotton is now confined to the Salt River Valley in Maricopa County, Ariz., and the acreage planted from year to year depends largely upon the yields and prices relative to those of upland cotton, which also has been grown extensively in that locality in recent years. The comparison was unfavorable in 1925 and consequently only about 24,000 acres of Pima were planted in 1926, the production amounting to about 12,000 bales. Prices were much more favorable to Pima in 1926 and a considerably increased acreage was planted in 1927.

To provide pure planting seed for the crop of 1927, cooperation was continued by the bureau with the Maricopa County Farm Bureau Pure Seed Association. Owing to contamination of the recent seed stocks resulting from the growing of upland cotton in all parts of Salt River Valley, it was necessary to fall back upon supplies of Pima seed produced in 1918 and 1920, before upland cotton had begun to be grown in this locality, which, fortunately, had been held in reserve by the Tempe Cotton Exchange. This seed was used to plant about 1,300 acres in 1926 on one of the ranches of the Southwest Cotton Co., where alone satisfactory isolation could be obtained. Field inspection of this increase acreage showed it to be entirely free from contamination with other cotton, and as an additional precaution buffer plantings of commercial Pima, totaling 480 acres, were rogued thoroughly by experts of the bureau, assisted by members of the plant-breeding staff of the University of Arizona. As a result of these activities, pure Pima seed was available in quantity sufficient to plant not less than 25,000 acres in 1927.

A strain of Pima which seems to be more uniform and productive and to have somewhat larger bolls than the present commercial stock was selected and grown on the seed farm of the United States Field Station at Sacaton, Ariz., in 1926, and the resulting seed, totaling about 5 tons, will be increased as rapidly as possible for general planting, in case field tests and spinning tests now in progress prove it to be definitely superior to the old stock of the variety.

ROOT-ROT CONTROL

On account of the destructive character of the root-rot disease of cotton, detailed observations and records of root-rot injuries have been made for several years at the United States Cotton Breeding Field Station at Greenville, Tex. Mapping of the root-rot areas of successive seasons showed the infected spots in the same general positions, with slow and gradual advances into new ground, but with little or no tendency to new infestations.

Experiments projected on the basis of these studies resulted in the discovery, announced in the report for 1924, that the root rot had not reappeared after two years of clean fallow, with no weeds or grass allowed to grow, on a plot where heavy root-rot infestations had been recorded for three years before the fallow treatment began. In the season of 1926 the results of the two preceding years were confirmed, the plot showing no evidence of root-rot injuries except by new invasion of the disease from a contiguous infected plot. Further experiments are being made to determine the application of the method and whether it is possible to obtain a complete exclusion of the disease with less than two seasons of clean fallow.

ABACÁ

In March and April, 1926, an inspection was made of the abacá plants introduced from the Philippine Islands in the early fall of 1925. These plants were first set out in quarantine at Flat Rock on Columbus Island near Bocas del Toro, Panama. A few carefully selected plants imported in sphagnum were set out at the Plant Introduction Station of the Panama Canal at Summit, Canal Zone. The introduction had included abacá buds, suckers, and rhizomes, packed in charcoal, excelsior, soil, and sphagnum. The best results were obtained with medium-sized suckers or small rhizomes planted either in sphagnum or in porous soil. Many of the plants packed in charcoal or in excelsior arrived in apparently fair condition, but there was a heavy loss after planting. On January 8, 1926, of the 1,438 plants in the original shipment 503 were growing. Many of these were producing suckers, and on March 12 there were 601 plants representing six different varieties.

There is a theory, widely accepted in the trade, that abacá fiber of good quality can be produced only in the Philippine Islands. A sample of fiber from one of the introduced abacá plants growing at Flat Rock on Columbus Island has been found by careful tests to compare very favorably in tensile strength with abacá from the Philippine Islands.

In 1903 some abacá seedlings germinated in the department's greenhouses in Washington were sent to the experiment station then recently established at Mayaguez, Porto Rico. They were planted in a moist, wooded ravine near the back part of the experiment station farm. In February, 1926, the director of the station brought them to the attention of a representative of the bureau. Specimens were identified as genuine abacá (*Musa textilis*) and different from the several introductions of abacá seedlings of degenerate type which yield fiber of inferior quality. There were 50 plants, 2 to 4 meters high, all free from disease and in good vigorous condition, although they had received no care in more than 20 years. The ground around the plants was cleared up, the suckers were set out, and many seedlings have been started from the seeds, forming the nucleus for a new source of propagating stock of abacá in the American Tropics.

HENEQUEN AND SISAL

In January and February, 1926, an inspection was made of the henequen and sisal selections at the experiment station at Mayaguez, Porto Rico. This work, begun in 1917, has been continued without interruption. Notes and measurements of the plants recorded each year show very clearly that the progenies of certain individual selected plants of both henequen (*Agave fourcroydes*) and sisal (*A. sisalana*) are decidedly superior to the progenies of other selections. The soil conditions on the farm of the station are not favorable for the growth of henequen or sisal, and the plants have not made as vigorous growth as could be expected on a more suitable soil. Both sisal and henequen plants are making a better growth in limestone soil in an experimental plot near Quebradillas in the northwestern part of Porto Rico.

The black-rot disease caused by the fungus *Colletotrichum agaves* had become very prevalent on the henequen plants in the selection plots. It rarely killed the plants, but upon careful inspection it was found that one or more leaves on at least 90 per cent of the plants were attacked by this disease. All diseased leaves on the best plot of 200 henequen plants were cut off and burned during the period of inspection, and instructions were given to have all the treated plants inspected frequently in order to exterminate the disease.

Prickly sisal (*Agave sisalana armata*), set out in the Guajataca plot near Quebradillas in 1918, is more vigorous and longer lived than the ordinary sisal with smooth-margined leaves, set out at the same time. Fully 75 per cent of the sisal plants in this

plot have sent up flower stalks terminating the life of the plant, while less than 35 per cent of the prickly sisal plants have poled.

FLAX

With equipment, though still rather crude, for retting and scutching larger quantities of the fiber flax straw grown in the experimental plots at East Lansing, Mich., it is possible to make more complete comparisons of fiber than could be done heretofore. Strains superior to the Saginaw variety have been developed by selection, but it will require time and further careful work to increase the seed of them.

The establishment of flax-spinning mills in Oregon offers a market for the flax fiber produced there, and there is an increasing interest in the production of flax fiber in eastern Michigan.

RUBBER PLANTS

CULTURAL CHARACTERS

The investigations of rubber-production possibilities in the United States are being based on a new principle or method of procedure as affording a better approach to the practical problems. Attention is given first to the cultural characters of the plants to determine which species are best adapted for our conditions, vigorous in growth, and readily propagated in large quantities. The cultural characters can be learned more readily and the more intensive and expensive investigations of special processes of extraction and utilization of the rubber or of by-products can be limited to the more promising species. Since the agricultural possibilities of a plant do not depend upon its abundance in the wild state, the investigation of agricultural possibilities should not be restricted to the species that have been considered in the past as commercial sources of rubber. This economy of effort is required on account of the large number of plants that are now known to produce rubber, which runs into hundreds of species. All of the available species are being tested under different conditions in southern California and southern Florida, and the more hardy species are also to be tested in other districts—in Arizona, New Mexico, Texas, and South Carolina.

HEVEA IN HAITI

Tapping experiments with Hevea rubber trees in Haiti have been continued since 1924 and are now entering the third year. The yields of rubber continue to be comparable with those of the East Indian plantations and afford the best evidence obtainable regarding the possibilities of producing rubber in the West Indies or under similar conditions in Central America and Mexico. The location in Haiti is near the north coast, in a latitude of nearly 20°, or much farther north than any other Hevea trees that have been tapped continuously in tropical America. It is to be expected that equally favorable conditions may be found in many districts of the West Indies as well as in Mexico and Central America.

AFRICAN RUBBER TREES IN FLORIDA

Two kinds of African rubber trees, Funtumia and Mascarenhasia, are included in the experimental plantings in southern Florida, and the seedlings have survived the winters of 1925 and 1926 in thriving condition. The growth of Mascarenhasia was not interrupted during the cool weather, and the plants began to flower and fruit in the second season. Both kinds of trees are rather handsome, with lustrous elliptical leaves, not unlike coffee, but attaining a larger size. It is possible that these trees may prove useful in southern Florida for ornamental planting, which would facilitate the investigation of their rubber-producing possibilities, as in the case of Cryptostegia.

MADAGASCAR RUBBER VINES

Two species of rubber-producing vines of the genus Cryptostegia from Madagascar have been planted as ornamentals in many localities in southern Florida and are now attracting attention as possible sources of rubber. It is known that rubber of good quality can be extracted by a grinding process like that applied to guayule. The proportion of rubber is much smaller than in guayule but the vines grow more rapidly. The planting of Cryptostegia as an ornamental will provide material and facilitate the investigation of its rubber-producing possibilities.

The seedlings grow rapidly, often attaining a height of 2 or 3 feet and beginning to flower in the first season. One species (*Cryptostegia madagascariensis*) forms a spreading bush 5 or 6 feet high, with a rather flat top, or more compact and rounded when trimmed. The other species (*C. grandiflora*) is more vigorous and has a stronger tendency to climb or to

trail over fences and gateways. The rubber vines showed little damage from the hurricanes of 1926, while many other ornamentals were ruined. Experiments in southern California have shown that both of the rubber vines can be grown there and that they thrive better under the dry conditions of the interior "desert" valleys than in the cooler climate of the coast belt.

FOREST-TREE DISEASES

BIG TREES AND TOURISTS

At the request of the National Park Service, a study was made of the injurious effect of tourist travel on plant life and in particular on the big trees which form the main attraction of the so-called Giant Forest in the Sequoia National Park, Calif. The investigation brought out clearly the fact that the tremendous increase in unrestricted tourist travel in the park has resulted in profound changes in the physiological environment of the trees regularly visited by the public, which have found visible expression in the slow but unmistakable decline in the health of the big trees. A continuation of existing conditions must undoubtedly lead to the premature death of some of the most highly prized individuals. In an extensive report to the Park Service a series of recommendations was given for systematic regulation of traffic in the vicinity of the trees most threatened, based partly on direct measures of soil improvement, partly on the psychological direction of the public itself. Detailed sample plans for individual cases have been drawn up, and the Park Service is putting them into effect as funds and man power permit. The report to the Park Service has also been used by the Forest Service to call the attention of forest supervisors to similar damage done by uncontrolled tourist traffic on public camping grounds and summer home sites on national forests.

CHESTNUT BLIGHT

The problem of the rate of deterioration of blight-killed chestnut is being studied from two angles: (1) The gross reduction in volume of wood suitable for certain uses in trees which have been infected for different periods of time, and (2) the reduction in the percentage of tannin in trees which have been dead for different periods of time. This study will furnish criteria which should materially aid owners of chestnut timber to estimate the loss they will suffer each year they permit their infected stands to remain uncut. The second part of this study is being conducted in cooperation with chestnut-extract companies, which are making all of the chemical analyses. The preliminary results have already been of value to the extract plants and have aided the Forest Service in managing the 1,500,000 acres of chestnut growth on the national forests. If the ultimate results confirm the preliminary indications, chestnut wood can be used for making tannin extract for as many as 30 years after the death of a tree. The percentage of tannin decreases and the quality of the tannin becomes poorer as time goes by, but dead chestnut wood remains valuable for making extract longer than had previously been supposed.

Efforts have been continued looking toward the establishment of small acreage blocks of promising blight-resistant chestnuts. Activities in this field have been principally centered on the Chinese hairy chestnut, which is one of the most promising so far discovered. Cooperative plantings were arranged with 55 cooperators, who received approximately 2,585 plants. In connection with this work a special distribution of an evergreen chinquapin, also of Chinese origin, was made in the South, outside of the native chestnut zone. Ninety-six cooperators received approximately 3,884 plants. The primary object of this work is to establish sources of home-grown seed.

HEART ROTS

Accumulated data of intensive studies of decay in incense cedar and white fir have been digested and presented in form of curves (volume over age and volume over diameter) for use in marking on timber sales and for the estimate of the prospective yield in producing stands. The curves permit a closer estimate of the loss and therefore also of the net wood production at consecutive stages in the development of the stand. In practical application the use of the curves and of the trends expressed therein aids in the choice of the most advantageous felling time, based on the representation in the stand of different age or diameter classes, and in the determination whether individual trees should be marked for cutting or may be allowed to remain standing without undue risk of loss until the next cutting. Finally, by permitting a closer estimate of the actual net wood produc-

tion in young timber, the curves furnish a sounder basis for the formulation of policies in the establishment and handling of the future forest. In several cases the trends illustrated by the curves have had a decisive influence in the modification of existing timber-sales contracts as well as in drafting of new contracts.

DECAY OF PULP

During the year particular attention has been paid to commercial experiments aimed at the control of molding and decay of ground wood pulp in storage. Two methods have been employed—spraying the pulp on the conveyer chain, and sprinkling with a hose as the pulp was piled in the storage shed. In both cases sodium fluoride was used as the fungicide. Apparently the results are unsatisfactory, due to the crude method of applying the chemical and consequent failure to get a sufficient amount of it evenly distributed on the pulp. Small amounts of sodium fluoride stimulate the growth of such molds as *Aspergillus niger*, and in certain places in the piles the pulp which was sprayed with the garden hose appears to have been badly spotted, perhaps as a result of some such stimulation. When the chemical was applied in too large quantities the operators objected to the way the salt crystallized out on the pulp laps. The spraying operations were directed principally at controlling brown spot. The conclusions are that where the pulp was closely piled and where sufficient sodium fluoride was used the treatment was successful.

DECAY OF PINE SLASH

A preliminary investigation of the decay of white-pine slash in southern New England has been made in cooperation with the Harvard Forest at Petersham, Mass. It is believed that further investigation is needed only in extending the area covered and the possible use of recording instruments to learn the exact variations in moisture and temperature, which appear to have very strong influence over the rate of decay. White-pine slash requires 15 to 20 years to decay completely; even then there is a residue of small branches broken into pieces 3 to 10 inches in length, which are nearly sound and capable of burning.

About 25 different fungi were found attacking the slash. Of these *Lenzites sepiaria* was the most important, as it not only rots sapwood but later also rots the heartwood of the attacked pieces. It works in the upper exposed branches, usually less than 3 inches in diameter. The flattening of the piles of slash is largely due to it, as it rots pockets of wood so that the branches fall into pieces 6 inches to 2 feet long. *Polystictus abietinus* is the next in importance. It is strictly a sapwood-rotting fungus and usually works only in thicker sapwood of the trunks. The other fungi are scavengers following up these two and finishing their work. Slash with much heartwood resists decay much longer than the average. Slash upon dry, sterile sand persists for extremely long periods. Partial shade, where the soil is not distinctly wet, favors rapid decay. On wet soils the slash should be left with a minimum portion in contact with the soil, to avoid water-logging. On dry soils with warm exposure, it should be left as compactly piled as possible to conserve moisture, which is necessary for rapid decay. In most of this area warm southern and eastern slopes favor rapid decay, while the cool northern and western ones retard it.

In July, 1926, an extensive survey was made of decay in yellow-pine slash on the Whitman National Forest. In October, 1926, a similar survey was made on the Deschutes National Forest. It was found that piled slash decayed very slowly, pieces in the interior of piles 12 to 13 years old being almost as hard and bright as when cut. Fire-scorched slash also decayed slowly. Cutting branches from the tops considerably retarded decay, particularly in the severed branches but also in the tops. Slash decayed most rapidly if left as it fell when the trees were cut. Such slash was badly decayed in 8 to 10 years. This means that from the standpoint of decay present slash-disposal practices of piling and burning or lopping and scattering can be modified toward simplicity with a resulting great saving in cost.

WHITE-PINE BLISTER RUST

White-pine blister rust, a fungous disease of white pines (five-needled pines) and Ribes (currants and gooseberries), is present in the New England States, New York, New Jersey, Pennsylvania, Michigan, Wisconsin, Minnesota, Washington, and Oregon. This disease kills white pines and seriously threatens the destruction of timber valued at approximately $550,000,000. Measures for local control of the disease, consisting of the sys-

tematic eradication of Ribes, the alternate host plants, within 900 feet of white-pine stands, were developed and demonstrated to be effective under eastern forest conditions.

In 1922, in cooperation with the affected Eastern States, a joint program was begun, to accomplish general control of the disease by securing the prompt application of control measures by pine owners. This program has progressed steadily, resulting in the protection of the white pines on 4,032,474 acres of land. In this work 38,900,179 Ribes plants have been eradicated at an average cost of 18 cents an acre. Including areas eradicated of Ribes prior to 1922 in experimentally developing and demonstrating practical control measures, a total of 5,069,377 acres of land, or an area approximately the size of Massachusetts, have been eradicated of 53,044,042 Ribes, of which 347,640 were cultivated plants. The eradication of Ribes in eastern white-pine forests is now going forward at the rate of over 800,000 acres a year.

In the West a program to delay the spread of the disease and develop local control measures was begun in 1924 in cooperation with California, Oregon, Washington, Idaho, and Montana. Scouting during the last year showed no further southward extension of the disease, but a marked increase in the amount of pine infection was found in the Olympic Peninsula, Wash., and near Nelson, British Columbia. In the course of time a further extension of the infected area is certain to result from these pine-infection centers.

Invasion by the disease of the western white-pine forests of eastern Washington, Idaho, and western Montana and the sugar-pine forests of Oregon and California is delayed through the maintenance of blister-rust quarantines and the eradication of the European or cultivated black currant (*Ribes nigrum*). The eradication of this plant has been completed in Montana and Oregon and is nearly finished in Idaho and Washington. In California it has been eradicated from about half of the State. This work has resulted in the destruction of 9,593 plantings comprising 136,165 plants.

Experimental work in developing and applying local control measures has been carried forward on national forests in Idaho and California to evolve practical and inexpensive methods of eradicating Ribes under western forest conditions. The progress made in this work indicates that protective measures can be developed and applied at costs which will make practicable their general application on western white-pine and sugar-pine forests. This work is supplemented by a control reconnaissance of important white-pine and sugar-pine forests to obtain information on blister-rust host plants and general topographical and forestry conditions as a basis for planning the application of local control measures in the western white-pine and sugar-pine regions.

Evidence has been obtained indicating more strongly than before the extreme susceptibility and high telia-producing capacity of *Ribes petiolare* and *Grossularia inermis* and relatively low capacity of *R. lacustre*. There are large differences between relation of Ribes species in susceptibility to aeciospores as compared with their susceptibility to uredinal intensification.

Wide spread of blister rust from pines to Ribes in the Pacific Northwest was mainly northward in 1926. Exceptionally early spring conditions through this region advanced development of Ribes leaves so much farther than aeciospore production that Ribes at lower elevations in regions about and to the south of the main pine infection localities were too far developed to be readily susceptible to aeciospores at the time the main production of these spores occurred. *Pinus albicaulis* appears to be of equal if not greater susceptibility than *P. monticola*.

WOODGATE RUST

A potentially dangerous gall rust of pine trees has appeared in the State of New York. It is a Peridermium rust characterized by large galls and witches' brooms. A cooperative emergency study of the disease has been made with the New York State Conservation Commission. So far the disease has been found for a certainty only on Scotch pine (*Pinus sylvestris*), a European pine, which is not vitally important for timber but is planted extensively on sand and other waste land and as an ornamental. On this species the disease can probably be controlled in time by seed selection and mass selection by thinning. If it were known that the rust would confine itself to Scotch pine, the issue would be less serious from a national standpoint, but danger lies in the fact that it is not yet known to what other hard pines the rust may spread. If the rust is one of the western forms now passing under the name of *Peridermium harknessii*, it may attack any

eastern hard pine, including the two valuable turpentine pines of the South. If, on the other hand, as seems more probable on the basis of present evidence, it is an importation and a total stranger, it may attack any hard pine in the country, including the immensely valuable and widely distributed western yellow pine, one of the most valuable timber trees of the country.

DRY-LAND AND IRRIGATION AGRICULTURE

DEVELOPMENT OF THE GREAT PLAINS

More general interest than usual has been manifest in the results obtained at the dry-land agricultural experiment stations, due to several factors. In the northern plains years of low yields have come about as may be expected, but coupled with postwar depression in prices have made poignant the hardships realized, so that in some considerable areas apprehension has been evidenced, especially in banking circles, as to the whole future of the region.

In eastern Colorado, the Panhandle of Texas, eastern New Mexico, and western Kansas, great activity has been under way in breaking out tens of thousands of acres of ranch lands to plant to wheat, to be handled with a newly developed and supposedly economical tractor and combine. Naturally, there has been a constant demand by the more thoughtful of these adventurers in wheat growing for information as to the best-paying methods of handling the soil.

Hundreds of families moved into the extreme southern part of the plains during the years when cotton prices were high, to grow this crop. Conditions here required entirely different methods of cultivation from those practiced in eastern Texas, Arkansas, and Louisiana, where these families lived before coming to the plains; and stations were asked to supply them much information. Since the fall in the price of cotton these people are casting around for a means of making a living, and data on grain sorghums, cowpeas, and other crops with which they are not familiar are in demand, as well as information on the feeding of these crops to livestock.

In the southern plains there has been a great demand for information on the growing of grapes, which come into bearing quickly, are comparatively free from insect and disease enemies, and often yield more at these dry-land stations than they do in the grape-growing regions of more eastern States.

In the northern plains there is an ever-growing demand for information on gardening and fruit growing specialties.

RECLAMATION OF ALKALI SOILS

Experiments in the reclamation of alkali soils are conducted on a series of unproductive plots at the Newlands Field Station (formerly Truckee-Carson), near Fallon, Nev., on the Newlands Reclamation Project. The soil of these plots, while designated a sandy loam, is really an alkaline mixture of sand and clay and becomes very hard when dry and takes water very slowly when irrigated. It was unproductive chiefly because it did not absorb water.

The plots have been under treatment since 1908. They have been manured, tile-drained, plowed, disked, harrowed, rolled, and pulverized. They have been treated with gypsum and with alum ore from a native deposit near the Lahontan reservoir. These various treatments have not been uniform for all plots, and prior to the application of alum ore in 1922 none seemed to show much benefit.

Following the alum treatment the land was seeded to alfalfa with oats as a nurse crop. A fair stand of alfalfa resulted. The following season, 1923, the growth of alfalfa was better than had ever been obtained, but the crop was light. In 1924 the crop growth was still better and the yield for the season was approximately 3 tons per acre. The improvement of growth continued during the seasons of 1925 and 1926. The average acre yield of the plots that have been under intensive treatment was 5.35 tons in 1926. The average acre yield of other alfalfa plots on the farm in 1926 was 4.35 tons. The yields obtained and the general appearance of the field indicate that substantial progress has been made in the improvement of the soil.

SOILS AND FERTILIZERS

ORGANIC SOILS

Some of the chief difficulties of adapting truck crops to organic soils are soil blowing and the occurrence of frost. Some of the extensive areas of organic soils are located geographically where the frost factor is rather serious. The topography is such as to intensify the frost hazard, and appar-

ently the radiation of heat from organic soils is very rapid. One phase of the study of truck-crop production on organic soils is the determination of practicable methods whereby the wind damage can be prevented. The suitability of different plants for shelter belts, such as the native willow, basket willow, various privets, white pine, arborvitae, Norway spruce, and various other kinds of plants, is being tried out. The prevention of soil blowing by keeping the surface moist through overhead irrigation is also being studied. The use of water in this way is likewise being taken into account as an influence in frost prevention. The results of this work are progressive, the work including studies of crop adaptation, plant food requirements, and methods of culture and handling.

GREENHOUSE SOILS

The use of peat as a source of organic material in greenhouse soils in place of manure is receiving continued attention. In a series of tests with clay loam as the basis for a greenhouse soil and with additions of peat, varying from one-eighth to three-fourths of the total volume of soil, both with and without the addition of manure, the results have been particularly favorable where one-fourth by volume of the soil is peat. With clay loam and manure only as a source of organic matter taken as unity, all of the combinations of soil with manure and peat, or with soil and peat without manure, gave increased numbers of blooms of carnations and roses. Clay loam and peat, one-fourth of the volume being peat, without manure proved particularly satisfactory. The number of rose and carnation blossoms from this combination was practically as large as where manure was also added. The quality of the blooms and the foliage from the peat mixtures were better than from the soil and the manure alone. The importance of the use of peat in greenhouse soils rests in the fact that in many places manure for composting is difficult to obtain. Many greenhouse men located where they can obtain a suitable grade of peat at low cost are employing it in their greenhouse soils largely as a result of this work.

FERTILIZER INFLUENCE ON CHLOROPHYLL FORMATION

The intensity of the green color of leaves is usually considered to be an indication of the health and vigor of growing crops, and its accurate measurement has always been a problem with investigators. A study of the chemistry of chlorophyll and its method of quantitative extraction has therefore been undertaken and much progress has been made. The green color of plants can be separated into two greens and two yellows, and these substances estimated separately by means of the colorimeter, or more accurately by means of the spectrophotometer. With these two new methods in hand it is now possible to study the effect which fertilizers and soil conditions have on the color of the plant, and thus obtain a measure of plant conditions. These methods for plant-pigment determination are also applicable to the measurement of the effects of certain diseases destructive to chlorophyll.

NEW FERTILIZER MATERIALS

Recent developments in nitrogen fixation and in phosphoric-acid manufacture have introduced into the commercial fertilizer trade a considerable number of new fertilizer materials following the use of new methods in chemical industry. Preliminary tests are usually made through greenhouse studies supplemented by field studies, and a number of compounds are thereby eliminated as being harmful to crops or as containing ingredients injurious or detrimental to plant growth. Experiments with these new products are therefore being carried on at a number of field points. The salts included are such compounds as urea, ammonium nitrate, ammonium phosphate, ammonium chloride, ammophos, and urea phos, using different crops to measure their effectiveness as fertilizer salts. This work was carried on during the growing season of 1926 on various field crops.

As a result of these field tests much valuable information to guide both the farmer and the manufacturer is being obtained regarding the use of such materials in agriculture. The results up to date show that compounds like ammonium nitrate, ammonium phosphate, urea, and ammonium chloride are generally good sources of nitrogen, and compare favorably with the more commonly used sources such as sodium nitrate or ammonium sulphate. Some of the nitrogen compounds or substances which accompany these newer nitrogen materials are of little value or are even inimical to crops.

FOREIGN PLANT INTRODUCTIONS

Three important agricultural explorations—in northern China and Manchuria, in southern and central China, and on the West Coast of Africa—were brought to a close during the year.

Two agricultural explorers have been dispatched to the British East African colonies of Tanganyika, Uganda, and Kenya. These explorers are to make a special study of the highlands of the region with a view to procuring and introducing new and promising forage crops. It is expected that the explorers will be in the field for about eight months.

As a result of the foreign agricultural work conducted by the bureau, aided by corresponding foreign cooperators, approximately 5,000 numbers of plants and seeds were received and added to our inventories. About 60 per cent of this material was received as a result of the department's explorers in the field; the remainder through foreign correspondence.

Further work has been carried on during the year with the object of securing a more thoroughly systematized distribution and testing of new foreign plant introductions. The list of special experimenters and collaborators has been carefully and critically studied and revised from time to time. A special effort has been made to obtain the services of experimenters connected with the State experiment stations, parks, and botanic gardens. The revisions of the lists which have been taking place from time to time have resulted in considerable simplification of the work without in any way detracting from the ability to get desired results. A total of approximately 370,000 plants, seeds, cuttings, roots, and bulbs were distributed to domestic experimenters, and approximately 7,000 were sent to foreign collaborators and others who are exchanging plant material with the department. Most of this material was grown at the several plant-introduction gardens, was carefully watched for the appearance of any new pests, and distributed only after careful inspection by officers of the Federal Horticultural Board.

The introduction and establishment of bamboo groves in the South is attracting considerable attention. Bamboos find many uses on the farm, and some of them have promise for commercial purposes. A special effort is being made to establish groves in cooperation with farmers. To this end arrangements have been made with farmers who are willing to devote from one-fourth acre to 1 acre to the plants. The principal bamboo involved is the large one known as the giant timber bamboo, a fine grove of which has been established near Savannah, Ga. Cooperative plantings were arranged during the year with 526 cooperators in the Southern and Pacific Coast States, who received approximately 45,559 plants.

MYCOLOGY

The proper development of a herbarium and its usefulness to plant pathology and the taxonomy of the fungi largely depend upon the accumulation of type or authentic material and abundant collections of all species and specimens in order to show morphological variations which occur and the various hosts and geographical distribution. The fact that type material of the numerous new species of fungi which are continually being described is frequently lost or inaccessible has led to the practice of urgently requesting portions of such material from authors in all parts of the world. In response to such requests and in exchange for duplicate specimens from the bureau's collections, about 50 per cent of the current types have been added to the herbarium. A record to show where type material is deposited, if in existence, and whether or not it is represented in this herbarium is maintained. In many cases the types of newly described species consist of living cultures. These cultures will form an important and integral part of the pathological collections. Additional material, both living and dead, accumulated for the Fusarium congress recently held at Madison, Wis., has been added to the herbarium. This set of cultures is valuable as representing authentic determinations and type material of the species studied and will be available for comparison and future studies of this important group of pathogens. Large collections of material resulting from recent investigations of citrus diseases have also been added.

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REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PUBLIC ROADS,
Washington, D. C., September 1, 1927.

SIR: I have the honor to submit herewith the report of the Bureau of Public Roads for the fiscal year ended June 30, 1927, covering the work done in connection with the construction of Federal-aid and national-forest roads and the economic and physical researches made in the highway field. A report of the work done by the agricultural engineering division of the bureau is submitted separately.

Respectfully,

THOS. H. MACDONALD,
Chief of Bureau.

Hon. W. M. JARDINE,
Secretary of Agriculture.

Through the Bureau of Public Roads, the Department of Agriculture cooperated during the past year with the highway departments of the several States and Hawaii in the construction of more than 8,300 miles of the Federal-aid highway system not previously improved with Federal assistance; and completed secondary improvements, necessitated by increased traffic, on 1,376 miles additional.

Independently, for the most part, it completed the construction of 453 miles of main highways in the national forests; and at the request of the National Park Service it surveyed and supervised the construction of important roads in the national parks and monuments, among them a number which will give access to hitherto unapproachable beauty spots of the national domain.

In cooperation with the State governments it completed the selection of the principal transcontinental roads which will form the United States highway system, and arranged for the uniform marking of these important arteries in all States as an aid to interstate travelers.

Continuing the distribution of war materials released by the War Department, it brought to practical completion this work begun shortly after the close of the World War. The wide variety of useful road material thus turned over to the State highway departments has served materially to advance the progress of road improvement in all States, and, especially, to preserve the roads constructed in a number of States in which the equipment necessary for efficient maintenance was lacking. Of the originally large and varied assortment of material available only a small quantity of explosives now remains to be distributed, and this distribution will be completed during the next 12 months. The value of the material distributed, exclusive of explosives, is estimated as approximately $242,500,000. The explosives distributed to June 30, 1927, are valued at about $18,600,000, making the total estimated value of material distributed to date approximately $261,100,000. Of this total, material valued at about $224,600,000 has been transferred to State highway departments; the amount used by the Department of Agriculture and other Government agencies is approximately $27,000,000, and the explosives made available to farmers have been valued at approximately $9,500,000.

Equaling, if not transcending, in value the services thus directly rendered in the construction of roads, the researches of the bureau have made available to engineers more exact knowledge of the fundamentals of highway design and economics. Of

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special importance are the studies of the magnitude and effects of the impact of heavy motor trucks upon highway surfaces, and the possibility of reducing the intensity of the impact forces by changes in the spring, wheel, and tire equipment of vehicles, and by refinements in the surface finish of roads.

Of fundamental importance, also, are the studies of soils with respect to their ability to support the loads of vehicles transmitted to them by pavements and road surfaces of various types; and the highway transport surveys conducted in a number of States and completed in several during the past year. These surveys, by developing exact information with regard to the volume of traffic using all sections of the highway system of a State provide a basis for a scientific administration of highway construction impossible without such knowledge.

Extending the methods of scientific study to the analysis of road-building operations, the bureau has been able to develop certain definite principles concerning the adjustment of labor and equipment and the utilization of both in the performance of various processes which, when applied by its own engineers and by contractors, have effected material reductions in cost, amounting in some cases to 50 per cent or more.

The results of these and similar investigations, disseminated in publications of the department and by addresses before bodies of engineers and contractors, are eagerly sought by road builders in the United States and throughout the world and, widely applied, have a multiplied effect of tremendous value.

The training of selected engineering students employed during the summer before graduation as assistants in the research work of the bureau, and subsequently on a full-time basis as apprentice engineers, is another means that has been adopted for the dissemination of the more exact knowledge resulting from research. Initiated for the purpose of supplying trained assistants to be employed in the construction work of the bureau, it is now found that the training may be offered to a larger number than has hitherto been possible, and this is being done in the belief that the body of specially trained young engineers will find employment in the service of the State highway departments as well as the bureau.

PROGRESS IN FEDERAL-AID ROAD CONSTRUCTION

The Federal-aid road projects completed during the fiscal year increased the mileage of improved roads in the Federal-aid highway system by 8,306.9 miles, bringing the total length of roads improved with Federal assistance up to 64,209.7 miles.

At the close of the year construction was in progress on 10,103 miles, and projects involving the improvement of 2,395.6 miles additional had been approved. Including the mileage of projects in these latter stages, all of which is included in the Federal-aid system, the total improved or in process of improvement with Federal aid at the close of the year was 76,708.3 miles. With the exception of a few hundred miles improved prior to the designation of the Federal-aid highway system in 1921, all of this mileage is included in the system.

The Federal-aid highway system now includes 185,772.2 miles of road selected by the constituted State and Federal highway officials as of primary importance for the accommodation of interstate highway traffic. Compared with the 3,000,000 miles of other highways in the United States, they are the most important of the Nation's highways, and their improvement as expeditiously as possible is an economic necessity of the highest importance.

Approximately a third of the system has already been improved with Federal assistance, and, with the exception of 7,469 miles, the 64,209.7 miles now reported as completed have been built in the six years since 1921. To this mileage the roads at present under construction and definitely planned will add nearly 12,500 miles.

With minor exceptions, the roads included in the Federal highway system are also parts of the several State highway systems, and are therefore eligible for improvement by the States alone under State legislation providing for such work.

For several years the unaided efforts of the States have resulted in the improvement of a greater mileage than has been built with Federal aid, and the major portion of this unaided State work has been applied to the improvement of the roads of the Federal-aid system. In the fiscal year 1926 the highways thus independently improved by the States aggregated approximately 12,500 miles; those improved with Fed-

eral aid totaled 10,610 miles. As appears from Table 1, the independent State work tends to increase, and for each mile improved with Federal cooperation there are now nearly 2 miles that are built by the States alone.

TABLE 1.—*Federal-aid mileage completed during the fiscal year 1927, including original and stage construction, compared with the total mileage completed in 1926 by State highway departments.*

Group of States	Federal-aid mileage (original and stage construction) completed, fiscal year 1927	Mileage completed by State highway departments, 1926	Ratio of Federal-aid to State program
			Per cent
New England	211.3	813.1	26.0
Middle Atlantic	489.5	1,680.0	29.1
South Atlantic	1,115.7	3,382.6	32.9
East North Central	714.4	4,644.7	15.4
West North Central	3,905.6	8,290.4	47.0
East South Central	585.1	1,987.7	29.4
West South Central	1,148.9	2,874.0	40.0
Mountain	1,146.4	2,113.1	54.3
Pacific	360.1	766.7	47.0
Total	9,677.0	26,552.3	36.4

The number of motor vehicles in use continues to increase annually at an approximately constant rate. The registration of 1926 was more than twice that of 1921, the year in which the Federal-aid system was designated, and the traffic served by the roads has, of course, increased proportionately. It is necessary, therefore, not only to extend the improved mileage but also gradually to raise the type of improvement on the roads already constructed as the demands of the traffic increase.

Of the Federal-aid roads already constructed amounting to 64,041.9 miles, as previously stated, 10,798.9 miles, largely in the Southern and Western States, are unsurfaced, the improvement consisting merely of the proper grading and draining of the roadbed. An additional large mileage is surfaced with inexpensive sand-clay and gravel. The improvement of these roads has been planned to meet the current requirements of the traffic and those of the immediate future. They are being faithfully maintained by the States under the constantly increasing usage, but there comes a time when maintenance of the lower form of improvement becomes more expensive than the construction of a higher form, and in recognition of this fact the Government, within the limits established by law, is cooperating with the States each year in the further improvement of roads previously built with Federal assistance.

During the fiscal year just ended the roads thus further improved have reached a total of 1,376.6 miles. This work, involving the construction of gravel surfaces on 989.6 miles and of 281.4 miles of concrete paving, with lesser mileages of other types, is not represented in the 8,306.9 miles reported as improved during the year, all of which were originally improved, nor does it add to the total of 64,041.9 miles improved up to the close of the year. From the standpoint of the year's work, however, and as improving the standard of service offered to traffic, it does constitute an important accomplishment. Adding this mileage to the mileage initially improved during the year, the total of all roads built is increased to 9,677 miles.

TYPES OF FEDERAL-AID ROADS

The 8,306.9 miles initially improved during the year include 2,537.1 miles of roads graded and drained, 612.1 miles surfaced with sand-clay, 2,309.5 miles surfaced with gravel, 137.1 miles of water-bound macadam, 462.7 miles of bituminous macadam, 159.9 miles paved with bituminous concrete, 2,002.7 miles with concrete, and 39.8 miles paved with vitrified brick. The remaining 45.9 miles were made up of bridges, all more than 20 feet in length.

As in previous years, the earth, sand-clay, and gravel constructed were mainly in the Southern and Western States. Of the 5,458.7 miles of these three types only 157.7 miles were in the States north of the Potomac and Ohio and east of the Mississippi. The small mileage of water-bound macadam was mainly in the four States of Georgia, Indiana, Ohio, and Texas, and the several higher types of construction, including bituminous macadam and better were built in all sections, constituting the highest percentages of the total, however, in the Northern and Eastern States where traffic is heaviest.

As shown by Table 2, there is an appropriate relation between the types of surfacing in the several geographic sections and what may be termed the potential motor-vehicle traffic as represented by the ratio of motor-vehicle registration to the mileage of the Federal-aid system in each section.

In this table the geographic divisions are arranged in the descending order of the ratio of their motor-vehicle registration to the mileage of the system, and it will be observed that, with the exception of the Pacific group, the several divisions would be rated in substantially the same order on the basis of their percentage of mileage suitable for medium and heavy motor-vehicle traffic. In the Pacific States the rather high percentage of the lower types is due to the construction of very considerable mileages of fine crushed rock and gravel roads, a type not extensively built in other parts of the country but peculiarly adapted to the necessities of the far Western States in which the problem of improving a very large mileage in a reasonable time can be dealt with in no other way. Much of the mileage thus constructed will be conserved until funds are available for further improvement by oil treatment—a process which experience has shown is capable of producing very satisfactory results.

TABLE 2.—*Relation of potential motor-vehicle traffic and types of Federal-aid roads completed to June 30, 1927*

Group of States	Number of motor vehicles per mile of Federal-aid system [1]	Percentage of mileage of roads completed	
		Bituminous macadam and higher types	Water-bound macadam and lower types
Middle Atlantic	363	96.4	3.6
New England	233	71.0	29.0
Pacific	209	35.7	64.3
East North Central	193	71.3	28.7
South Atlantic	96	39.8	60.2
West South Central	81	23.8	76.2
East South Central	69	27.6	72.4
West North Central	66	15.4	84.6
Mountain	34	9.3	90.7
All States	118	32.7	67.3

[1] As registered in the several States during the calendar year 1926.

The wide range in traffic density in various parts of the country is indicated by the spread between the 363 vehicles per mile of Federal-aid system in the Middle Atlantic States and the corresponding ratio of 34 in the Mountain States. East of the Mississippi and north of the Ohio and the Potomac the average number of motor vehicles per mile of the system exceeds 200; in the rest of the country it is less than 100. This is a measure of the relative traffic requirements of the two broad regions, and it will be observed that the percentages of high and low types of improvement are in accord with these requirements.

LOW-TYPE HIGHWAYS FURTHER IMPROVED

The further improvement of the 1,376.6 miles of previously constructed low-type Federal-aid highways is in accordance with the agreements entered into by the States and the Government at the time these highways were originally improved. The original improvement was regarded as merely the first stage of a progressive improvement to be carried out as traffic requirements dictated and funds became available.

Nearly three-quarters of the mileage on which this further work was completed during the year was formerly improved as graded and drained earth road and has now been surfaced with gravel. Most of the rest of the 1,376.6 miles consists of roads on which a former gravel surface has been replaced by a higher type of surfacing or pavement.

This secondary construction completed during the year consisted in detail of 21 miles of roads graded and drained, 989.6 miles to which a gravel surface was applied, 20.3 miles surfaced with water-bound macadam, 25.6 miles on which a bituminous macadam surface was substituted for one of lower type, and the construction of 38.7 miles of bituminous concrete and 281.4 miles of Portland-cement concrete pavements, making a total of 1,376.6 miles, which is subdivided by States in Table 16.

The effect of this secondary construction is to raise the general level of improvement of the Federal-aid system very materially. As shown by Table 3, the mileage of graded and drained earth road at the close of the preceding year was 9,653.7 miles. This was increased by only 1,145.2 miles during the last year, although the mileage of such roads newly built during the year was 2,537.1 miles.

TABLE 3.—*Mileage of Federal-aid highways at the close of the fiscal years 1926 and 1927 and percentage of increase*

Type	Mileage at close of fiscal year 1926	Mileage at close of fiscal year 1927	Percentage increase during fiscal year 1927
Graded and drained	9,653.7	10,798.9	12.8
Sand-clay	4,926.2	5,721.7	16.0
Gravel	22,547.3	25,547.5	13.3
Water-bound macadam	1,123.3	1,309.9	16.7
Bituminous macadam	3,176.3	3,680.0	16.0
Bituminous concrete	1,626.1	1,818.9	11.8
Portland-cement concrete	11,976.6	14,391.2	20.2
Brick	752.0	773.8	3.0
Total	55,781.5	64,041.9	14.8

Similarly, although the mileage of the three lowest types of construction—earth, sand-clay, and gravel—newly constructed during the year was 5,458.7 miles, or 66 per cent of the total mileage of roads built, the mileage of these types in the portion of the system improved with Federal aid increased by only 4,940.9 miles, or less than 60 per cent of the net increase in improved mileage.

The types of road least suitable for motor-vehicle traffic are the graded and drained earth roads and those surfaced with sand-clay and water-bound macadam; those best adapted to such traffic are the bituminous concrete, Portland-cement concrete, and brick pavements. In view of the continuing increase in motor-vehicle registration and the corresponding increase in motor traffic throughout the country, it is interesting to observe from Table 3 that the increase in the mileage of the three lower types during the year was only 25.8 per cent of the total increase in mileage, although these same types constitute 39.8 per cent of the newly completed mileage.

The net increase of the types most suitable for motor-vehicle traffic was 31.9 per cent, although the newly constructed mileage of these types was only 26.7 per cent of the total new mileage. The gravel type, which is the cheapest type capable of resisting moderate motor-vehicle traffic and the usual choice for the secondary improvement of earth roads, increased 36.4 per cent in net mileage, although in the new construction it constituted only 28 per cent. These differences between the new construction and net increases of the several types reflect the beneficial results of stage construction.

The mileage of roads under construction and approved for construction at the end of the year is approximately the same as at the close of the preceding year, indicating that progress during the fiscal year 1928 will be practically the same as during the year just passed.

BRIDGE BUILDING INCREASES

The bridges completed during the fiscal year have an aggregate length of 45.9 miles, which is more than twice the mileage completed during the preceding year. Bridges under construction and approved for construction have an aggregate length of 64.5 miles, exceeding by 5.4 miles the total length of structures in the corresponding stages of progress at the beginning of the year.

Including the structures just completed, the Federal-aid bridges now standing have a total length of 167.6 miles, over a fourth of which was added during the last year.

All of these structures are more than 20 feet in span, and one, completed during the year, is more than two miles in length. This is the bridge over the Choctawhatchee River in Florida on the road between Westville and Careyville. Two others completed during the year are more than a mile in length. One of these, the bridge over the east fork of the White River on the road between Bedford and Mitchell in Indiana, is 1.4 miles long; the other, spanning the Platte River in Nebraska, is 1.1 miles in length.

Other outstanding bridges recently opened to traffic are the bridge over the Alabama River near Montgomery, Ala.; the American River bridge at Sacramento, Calif.; the structure spanning Pass Manchac on the road between New Orleans and Hammond, La.; and the Willamette River bridge at Harrisburg, Oreg.

A list of the bridges completed during the year which cost $75,000 or more is given in Table 4. These, the longest structures completed, vary in length from a tenth of a mile to more than 2 miles and have an aggregate length of 9.7 miles, which is only about a fifth of the total length of the structures completed during the year. The remainder is made up of numerous smaller and less expensive bridges.

TABLE 4.—*Federal-aid bridges completed during the fiscal year 1927 at a cost of $75,000 or more each*

State	Location	Stream	Length
			Miles
Alabama	Between Montgomery and Prattville	Alabama River	0.4
California	Between Montebello and Whittier	San Gabriel River	.1
Do	Between Red Bluff and Oregon State Line	Doney Creek	.1
Do	At Sacramento	American River	.6
Colorado	At Alamosa	Rio Grande del Norte	.2
Florida	Between Westville and Careyville	Choctawhatchee River.	2.2
Georgia	Between Savannah and Darien	Ogeechee River	.3
Idaho	At Salmon	Salmon River	.2
Indiana	Between Bedford and Mitchell	White River, East Fork.	1.4
Louisiana	Between Hammond and New Orleans	Pass Manchac	.5
Minnesota-North Dakota.	Between Pembina, N. Dak., and St. Vincent Minn.	Red River of the North.	.3
Missouri	Between St. Joseph and Bayfield	Platte River drainage ditch.	.1
Montana	At Glendive	Yellowstone River	.3
Nebraska	Between Yutan and Millard	Platte River	1.1
North Carolina	Between Charlotte and Wilmington	Pee Dee River	.3
Oklahoma	Between Harrah and Meeker	North Canadian River	.2
Oklahoma-Texas	Between Hugo, Okla., and Arthur City, Tex.	Red River	.2
Oregon	At Albany	Willamette River	.2
Do	At Harrisburg	do	.4
Texas	At La Grange	Colorado River	.3
Do	Between Hearne and Gause	Brazos River	.2
Washington	Between Skokomish Indian Reservation and Bremerton.	Skokomish River	.1
Total			9.7

It is to be hoped that the increase in Federal-aid bridge construction evident in the mileage recently completed and under construction will continue, and that to a greater degree the States will resort to this means of reducing the local expense of large bridge structures rather than the distinctly objectionable means of permitting such important structures to be privately financed.

The bridges are essential parts of the Federal-aid system. Congress has given abundant evidence of its intention that this interstate system shall, so far as possible, be free for the use of the citizens of all States, by forbidding the collection of tolls on all roads in the construction of which the Government participates and by prohibiting the use of Federal funds for the improvement of roads which constitute the immediate approach to toll bridges.

The act passed at the last session which permits the financing of the State's portion of the cost of Federal-aid bridges by means of tolls collected by the State or its subdivisions removes the last reasonable excuse for permitting expensive bridges to be built by private initiative.

The large earnings of toll bridges on important highways are made possible by the public improvement of the highways. The very great attractiveness of such bridges to private investors is proof of the high return upon the capital invested. It is common knowledge that the entire cost of many expensive and important structures operated privately has been repaid by the tolls charged in a very few years, leaving the subsequent earnings, less a small amount for maintenance, as clear profit.

There seems to be no good reason why the States should not avail themselves of the recent Federal concession, permitting, as it does, the payment of a full 50 per cent of the cost of the bridges from Federal funds and the financing of the remainder on the basis of tolls publicly collected. Certainly it would seem that the new provision of law removes the principal condition which hitherto has given some measure of justification to private toll-bridge franchises, i. e., the impracticability of devoting the large sum of State money required for the construction of a large bridge to an improvement of such limited extent, for it is now possible for the State to finance its portion of the cost without using any part of the regular highway revenue.

THE COST OF THE ROADS

The total cost of the 8,306.9 miles of original construction and the 1,376.6 miles of stage construction completed during the year was $182,770,089.53, of which the Federal Government paid

$81,330,357.82, or 44.5 per cent, and the States the balance. These expenditures were made over the period required to construct the roads brought to completion during the year, which was approximately two years, and during the same period additional expenditures were made upon other projects under construction.

The actual disbursement of Federal-aid funds during the year was $81,371,013.03, as shown in Table 5. This is a reduction of about $6,000,000 below the disbursement of the preceding year, which, in turn, was $8,000,000, less than the disbursement of the year before. As stated in the report a year ago, it may be expected that the annual expenditure will be still further reduced in the future until—the accumulated balances of earlier appropriations being expended—the program of expenditure reaches the rate set by the annual authorization of $75,000,000 of recent years.

The largest disbursements during the year were made to Missouri, New York, and Texas. To each of these States the Federal Government paid during the year more than $4,000,000. Pennsylvania received more than $3,000,000 and all other States received less than that amount.

In proportion to the total road mileage of the several geographic divisions, the Federal-aid disbursement in 1927 was greatest in the Middle Atlantic States and least in the West South Central States. On this basis the first of these two groups received more than twice as much as the second, and between these two extremes the other areas, ranked in descending order, were as follows: New England, South Atlantic, Pacific, East North Central, East South Central, West North Central, and Mountain.

TABLE 5.—*Federal-aid disbursements to States, fiscal year 1927*

States	Federal-aid disbursement	States	Federal-aid disbursement
Alabama	$1,206,220.03	New Hampshire	424,768.85
Arizona	721,244.42	New Jersey	732,592.69
Arkansas	986,717.98	New Mexico	1,110,390.27
California	2,978,864.97	New York	4,367,134.87
Colorado	1,289,506.73	North Carolina	2,441,688.30
Connecticut	613,841.51	North Dakota	2,530,261.21
Delaware	450,337.15	Ohio	2,580,502.50
Florida	1,434,043.79	Oklahoma	1,339,252.44
Georgia	2,535,285.99	Oregon	1,301,855.33
Idaho	1,235,844.70	Pennsylvania	3,180,313.25
Illinois	2,427,392.92	Rhode Island	466,586.24
Indiana	2,055,735.74	South Carolina	1,187,023.41
Iowa	2,845,968.50	South Dakota	1,074,687.39
Kansas	2,730,002.55	Tennessee	1,793,804.55
Kentucky	1,420,029.31	Texas	4,710,228.42
Louisiana	1,124,562.53	Utah	830,082.69
Maine	878,953.95	Vermont	625,423.73
Maryland	650,106.91	Virginia	1,868,896.29
Massachusetts	799,464.35	Washington	1,146,672.36
Michigan	2,692,098.35	West Virginia	648,202.63
Minnesota	2,590,339.01	Wisconsin	2,357,068.54
Mississippi	1,589,120.64	Wyoming	696,804.42
Missouri	4,099,338.56	Hawaii	253,061.09
Montana	894,779.83		
Nebraska	2,370,258.28	Total	81,371,013.03
Nevada	1,083,652.86		

The annual highway bill of the country is in excess of a billion dollars, including all expenditures of the Federal, State, and county and other local governments, for construction, maintenance, and administration. Of this amount the Federal expenditure is less than 8 per cent, and the States alone spent, of their own funds, more than six times the amount they received from the Federal Government. It is apparent, therefore, that the Federal expenditure, at the current rate, is not extravagant, but is, in fact, extremely moderate in view of the large and growing interstate traffic.

That the offer of Federal aid has not induced the States to make expenditures in excess of those they would otherwise have made is indicated by the fact, as shown by Table 6, that in 1926 every State, with two exceptions only, made expenditures, some very large, in addition to those for the Federal-aid roads, the total of such additional expenditures being $452,798,000, or more than four times the amount spent to match Federal aid. These are State expenditures only.

They do not include the amounts spent by the counties independent of State control, which, doubtless, were practically equal to those of the States.

TABLE 6.—*Approximate disbursements by State highway departments in excess of expenditures for Federal-aid roads, calendar year 1926*

State	State disbursements for other than Federal-aid roads
Alabama	$7,479,000
Arizona	1,993,000
Arkansas	7,080,000
California	14,544,000
Colorado	3,472,000
Connecticut	9,729,000
Delaware	2,909,000
Florida	11,642,000
Georgia	4,158,000
Idaho	1,643,000
Illinois	20,112,000
Indiana	8,004,000
Iowa	10,660,000
Kansas	5,468,000
Kentucky	6,264,000
Louisiana	8,669,000
Maine	8,222,000
Maryland	8,631,000
Massachusetts	11,706,000
Michigan	20,334,000
Minnesota	11,521,000
Mississippi	2,079,000
Missouri	21,957,000
Montana	
Nebraska	2,647,000
Nevada	623,000
New Hampshire	2,535,000
New Jersey	21,325,000
New Mexico	2,012,000
New York	31,486,000
North Carolina	32,395,000
North Dakota	
Ohio	23,562,000
Oklahoma	6,434,000
Oregon	7,974,000
Pennsylvania	42,345,000
Rhode Island	2,385,000
South Carolina	5,846,000
South Dakota	2,932,000
Tennessee	9,316,000
Texas	9,365,000
Utah	1,188,000
Vermont	2,145,000
Virginia	7,226,000
Washington	5,334,000
West Virginia	16,458,000
Wisconsin	7,258,000
Wyoming	1,731,000
Total	452,798,000

The two States that made no expenditures for highway purposes other than for Federal-aid roads were Montana and North Dakota. In these States practically all road improvement, except that included in the Federal-aid program, is carried on under the control of the counties.

In growing proportion the funds with which the States carry on all work of road improvement are supplied by the users of motor vehicles. In 1926 the sum thus raised by motor-vehicle license fees and gasoline taxes was $474,304,078, exceeding by nearly $70,000,000 the total of the preceding year.

The State funds required to match a Federal appropriation of $75,000,000 a year in the proportions required by the Federal law amount to $67,090,520, which, as shown by Table 7, is raised seven times over by the motor-vehicle taxes. In fact, the motorists now contribute almost enough to finance the entire program of the States, including the State portion of the cost of the Federal-aid roads, and, as the registration of motor vehicles is still growing, it may be anticipated that the State and Federal-aid roads will be paid for in the future to an increasing degree by those who regularly use them.

TABLE 7.—*Comparison of State motor-vehicle revenues and funds required to match Federal appropriations*

States	State funds required to match Federal appropriation of $75,000,000 apportioned Dec. 31, 1926	Gross income from motor-vehicle license fees and gasoline taxes, calendar year 1926
Alabama	$1,547,220	$5,447,903
Arizona [1]	404,153	1,446,059
Arkansas	1,277,896	7,241,672
California [1]	1,652,178	24,979,356
Colorado [1]	1,078,045	3,599,128
Connecticut	472,685	8,910,040
Delaware	365,625	1,165,991
Florida	899,451	18,195,954
Georgia	1,979,209	9,034,865
Idaho [1]	629,984	2,508,147
Illinois [2]	3,154,429	14,047,208
Indiana	1,926,772	14,064,917
Iowa	2,044,999	15,050,843
Kansas	2,068,532	9,106,518
Kentucky	1,417,947	9,066,823
Louisiana	1,013,308	6,702,033
Maine	680,794	4,178,711
Maryland	635,119	5,222,122
Massachusetts [2]	1,089,100	13,077,857
Michigan	2,214,691	27,035,461
Minnesota	2,120,741	14,781,248
Mississippi	1,307,879	6,061,612
Missouri	2,405,175	13,564,170
Montana [1]	1,196,462	1,900,095
Nebraska	1,585,138	6,676,024
Nevada [1]	132,783	615,738
New Hampshire	365,625	2,479,487
New Jersey [2]	934,611	11,870,529
New Mexico [1]	684,218	1,276,594
New York [2]	3,635,217	28,786,421
North Carolina	1,713,356	17,186,473
North Dakota	1,194,951	2,566,574
Ohio	2,762,209	23,076,139
Oklahoma [1]	1,406,377	11,727,454
Oregon [1]	716,918	9,351,588
Pennsylvania	3,335,735	35,827,131

[1] States not on 50–50 basis on account of public lands and nontaxable Indian lands.
[2] No gasoline tax assessed.

TABLE 7.—*Comparison of State motor-vehicle revenues and funds required to match Federal appropriations*—Con.

States	State funds required to match Federal appropriation of $75,000,000 apportioned Dec. 31, 1926	Gross income from motor-vehicle license fees and gasoline taxes, calendar year 1926
Rhode Island	$365,625	$2,474,794
South Carolina	1,054,988	6,448,527
South Dakota [1]	973,507	4,353,938
Tennessee	1,614,766	7,443,820
Texas	4,497,272	19,589,769
Utah [1]	226,486	1,892,057
Vermont	365,625	2,249,675
Virginia	1,442,714	10,480,145
Washington [1]	949,255	9,538,096
West Virginia	793,636	6,651,610
Wisconsin	1,870,455	14,284,295
Wyoming [1]	521,034	1,068,467
Hawaii [2]	365,625	
Total	67,090,520	474,304,078

[1] States not on 50–50 basis on account of public lands and nontaxable Indian lands.
[2] No tax data available.

As shown by Table 7, every State has sufficient revenue from the taxation of motor vehicles to match the Federal contribution—most of them much more than enough. The Federal-aid roads, in general, are the most important roads in all States, i. e, they are used more extensively by motor-vehicle operators than other roads. Their improvement, by reducing the cost of vehicular operation and maintenance, benefits the users far beyond the amount of the taxes paid, and this fact is so clearly recognized by the motorists themselves that these particular taxes are paid more willingly, perhaps, than any others. It may be concluded, therefore, with positive assurance, that the expenditures for State and Federal-aid road improvement are in no considerable degree responsible for the complaint of burdensome taxation.

FEDERAL-AID APPORTIONMENT EQUITABLE

As stated in the report for the fiscal year 1926, the apportionment of Federal aid is quite consistent with the needs of the several sections of the country, as indicated by the ratio of motor-vehicle registration to the mileage of the Federal-aid system in each area. This ratio is a measure of potential traffic on the system, and, according as it is high or low, expresses the need for a higher or lower type of road improvement, i. e., for a greater or less expenditure.

A year ago it was shown that the total apportionment of Federal-aid appropriations to each of the several geographic divisions of the country, considering the mileage in each, was in remarkably close agreement with the requirements of traffic, as indicated by the ratio referred to above.

The changes in motor-vehicle registration in the last year and the appropriation that has since become available have not altered this very satisfactory relation. As shown by Table 8, the average Federal-aid apportionment per mile of system is still consistent with the potential traffic, as indicated by the motor-vehicle registration per mile. The several areas are arranged in the table in the descending order of their average Federal-aid apportionment per mile, and it will be seen that, with the exception of the East South Central and Mountain States, they would be ranked in the same order in respect to their potential traffic. The two exceptional groups are shown to have received a somewhat disproportionate apportionment in consideration of their potential traffic.

TABLE 8.—*Apportionment of Federal aid per mile of Federal-aid highway system compared with motor-vehicle registration*

Group of States	Mileage of Federal-aid system approved to June 30, 1927	Federal-aid funds apportioned to States July 11, 1916 to June 30, 1927	Motor vehicles registered during 1926	Average Federal-aid apportionment per mile of system	Motor vehicle registration per mile of system
Middle Atlantic	10,818.4	$81,756,959	3,922,033	$7,566	363
New England	5,917.7	33,352,257	1,378,721	5,636	233
Pacific	10,513.0	47,895,109	2,197,322	4,556	209
East North Central	27,945.9	123,478,085	5,404,142	4,418	193
East South Central	14,443.3	60,858,685	992,326	4,214	69
South Atlantic	21,728.3	90,172,875	2,093,402	4,150	96
Mountain	21,735.3	88,916,981	735,286	4,091	34
West South Central	24,676.6	86,084,797	1,998,726	3,489	81
West North Central	47,993.7	130,518,474	3,167,938	2,719	66
All States	185,772.2	[1] 743,034,222	21,889,896	4,000	118

[1] Including the apportionment of $1,465,778 to Hawaii the total apportionment up to June 30, 1927, was $744,500,000.

As a year ago, the greatest motor-vehicle registration per mile is in the Middle Atlantic States, and this group, including New York, Pennsylvania, and New Jersey, is also shown to have received the largest apportionment of Federal aid in proportion to the mileage of the Federal-aid system within their borders. Next to these States in order of potential traffic and also in the magnitude of the apportionment are the New England States.

The West North Central States' apportionment per mile of highway in the system is lower than that of any other group and their potential traffic is greater than that of only one other group.

SUMMARY OF FEDERAL-AID ROAD WORK BY STATES

The progress made in each of the States during the year and the results of the 11 years of Federal-aid road construction are set forth in the following condensed summary for each State.

ALABAMA

The Federal-aid highway system includes 3,884 miles, of which 1,494 miles have been improved with Federal aid. Of the improved mileage, 78.3 miles were added during the year. At the close of the year 299.9 miles were under construction and 1.9 miles were approved.

The mileage improved with Federal aid consists of 72.3 miles of graded and drained earth roads, 413.2 miles of sand-clay, 780.9 miles of gravel, 11.6 miles of water-bound macadam, 53.2 miles of bituminous macadam, 87.5 miles of bituminous concrete, and 71.9 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 3.3 miles.

The total cost of all Federal-aid roads completed, including 10.2 miles of stage construction, was $22,394,983.26, of which the Federal share was $10,678,040.69. The disbursement of Federal funds to the State was $1,206,220.03. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $15,896,675, leaves a balance of $4,771,272.49 unexpended funds to the credit of the State.

ARIZONA

The Federal-aid highway system includes 1,498 miles, of which 835.7 miles have been improved with Federal aid. Of the improved mileage, 68.6 miles were added during the year. At the close of the year 27.8 miles were under construction and 19.1 miles were approved.

The mileage improved with Federal aid consists of 124.2 miles of graded and drained earth roads, 131.4 miles of sand-clay, 428.2 miles of gravel, 14.2 miles of water-bound macadam, 26.6 miles of bituminous concrete, and 108.5 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.6 miles.

The total cost of all Federal-aid roads completed, including 7.1 miles of stage construction, was $12,288,747, of which the Federal share was $6,750,136.37. The disbursement of Federal funds to the State was $721,244.42. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $10,674,243, leaves a balance of $3,693,858.39 unexpended funds to the credit of the State.

ARKANSAS

The Federal-aid highway system includes 5,021.1 miles, of which 1,587.4 miles have been improved with Federal aid. Of the improved mileage, 168.9 miles were added during the year. At the close of the year 184.7 miles were under construction and 19.4 miles were approved.

The mileage improved with Federal aid consists of 3 miles of sand-clay, 1,059.5 miles of gravel, 48.4 miles of water-bound macadam, 98.9 miles of bituminous macadam, 256.3 miles of bituminous concrete, and 118.2 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 3.3 miles.

The total cost of all Federal-aid roads completed was $22,638,788.64, of which the Federal share was $9,675,983.97. The disbursement of Federal funds to the State was $986,717.98. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $12,883,700, leaves a balance of $2,794,443.71 unexpended funds to the credit of the State.

CALIFORNIA

The Federal-aid highway system includes 4,771.5 miles, of which 1,365.3 miles have been improved with Federal aid. Of the improved mileage, 195.6 miles were added during the year. At the close of the year 92.4 miles were under construction and 4.5 miles were approved.

The mileage improved with Federal aid consists of 314 miles of graded and drained earth roads, 348.5 miles of

gravel, 18.6 miles of water-bound macadam, 63.1 miles of bituminous macadam, 85.9 miles of bituminous concrete, and 530 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 4.9 miles.

The total cost of all Federal-aid roads completed, including 34 miles of stage construction, was $37,590,843.42, of which the Federal share was $18,275,-993.48. The disbursement of Federal funds to the State was $2,978,864.97. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $24,556,252, leaves a balance of $5,457,231.73 unexpended funds to the credit of the State.

COLORADO

The Federal-aid highway system includes 3,332 miles, of which 936.6 miles have been improved with Federal aid. Of the improved mileage, 166.6 miles were added during the year. At the close of the year 141.5 miles were under construction and 2.9 miles were approved.

The mileage improved with Federal aid consists of 231.7 miles of graded and drained earth roads, 105.7 miles of sand-clay, 409 miles of gravel, 4 miles of bituminous concrete, and 207.3 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 6 miles.

The total cost of all Federal-aid roads completed, including 5.3 miles of stage construction, was $18,184,354.89, of which the Federal share was $9,269,-990.10. The disbursement of Federal funds to the State was $1,289,506.73. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $13,702,332, leaves a balance of $4,283,337.09 unexpended funds to the credit of the State.

CONNECTICUT

The Federal-aid highway system includes 835.4 miles, of which 151.1 miles have been improved with Federal aid. Of the improved mileage, 24 miles were added during the year. At the close of the year 50.1 miles were under construction and 13 miles were approved.

The mileage improved with Federal aid consists of 0.2 mile of gravel, 8.7 miles of water-bound macadam, 27.1 miles of bituminous macadam, and 114.9 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 0.3 mile.

The total cost of all Federal-aid roads completed was $7,612,390.21, of which the Federal share was $2,691,-696.71. The disbursement of Federal funds to the State was $613,841.51. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $4,806,366, leaves a balance of $1,839,661.74 unexpended funds to the credit of the State.

DELAWARE

The Federal-aid highway system includes 415.8 miles, of which 164.5 miles have been improved with Federal aid. Of the improved mileage, 40.2 miles were added during the year. At the close of the year 27.9 miles were under construction and 11 miles were approved.

The mileage improved with Federal aid consists of 5 miles of water-bound macadam, 153.1 miles of Portland-cement concrete, and 6.2 miles of brick, in addition to which there are bridges with a total length of 0.2 mile.

The total cost of all Federal-aid roads completed was $6,350,437.65, of which the Federal share was $2,402,-277.97. The disbursement of Federal funds to the State was $450,337.15. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $2,839,683, leaves a balance of $472,267.59 unexpended funds to the credit of the State.

FLORIDA

The Federal-aid highway system includes 1,926 miles, of which 315.6 miles have been improved with Federal aid. Of the improved mileage, 65.9 miles were added during the year. At the close of the year 125.8 miles were under construction and 24.2 miles were approved.

The mileage improved with Federal aid consists of 9.8 miles of graded and drained earth roads, 21.1 miles of sand-clay, 34.8 miles of gravel, 18.5 miles of water-bound macadam, 72.7 miles of bituminous macadam, 41.8 miles of bituminous concrete, 103.9 miles of Portland-cement concrete, and 10.1 miles of brick, in addition to which there are bridges with a total length of 3 miles.

The total cost of all Federal-aid roads completed, including 24.8 miles of stage construction, was $10,391,903.41, of which the Federal share was $5,011,-696.35. The disbursement of Federal funds to the State was $1,434,043.79. This, added to the disbursements made

during previous years and subtracted from the State's total apportionment of $8,984,405, leaves a balance of $2,701,356.63 unexpended funds to the credit of the State.

GEORGIA

The Federal-aid highway system includes 5,558.4 miles, of which 2,369.8 miles have been improved with Federal aid. Of the improved mileage, 394.3 miles were added during the year. At the close of the year 137.5 miles were under construction and 0.3 mile was approved.

The mileage improved with Federal aid consists of 166 miles of graded and drained earth roads, 1,257.7 miles of sand-clay, 423.3 miles of gravel, 73.1 miles of water-bound macadam, 123.1 miles of bituminous macadam, 25.9 miles of bituminous concrete, 275.2 miles of Portland-cement concrete, and 0.5 mile of brick, in addition to which there are bridges with a total length of 25.2 miles.

The total cost of all Federal-aid roads completed, including 156 miles of stage construction, was $36,023,188.89, of which the Federal share was $17,101,498.97. The disbursement of Federal funds to the State was $2,535,285.99. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $20,411,162, leaves a balance of $2,435,761.10 unexpended funds to the credit of the State.

IDAHO

The Federal-aid highway system includes 2,770 miles, of which 950.7 miles have been improved with Federal aid. Of the improved mileage, 177 miles were added during the year. At the close of the year 83.9 miles were under construction and 9.3 miles were approved.

The mileage improved with Federal aid consists of 228.7 miles of graded and drained earth roads, 22.7 miles of sand-clay, 591.4 miles of gravel, 4.3 miles of water-bound macadam, 4.9 miles of bituminous macadam, 61 miles of bituminous concrete, and 35.9 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2 miles.

The total cost of all Federal-aid roads completed, including 83.5 miles of stage construction, was $14,160,210.06, of which the Federal share was $7,669,247.11. The disbursement of Federal funds to the State was $1,235,844.20. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $9,494,820, leaves a balance of $1,569,930.43 unexpended funds to the credit of the State.

ILLINOIS

The Federal-aid highway system includes 6,616.8 miles, of which 1,543.4 miles have been improved with Federal aid. Of the improved mileage, 76.3 miles were added during the year. At the close of the year 343.4 miles were under construction and 187 miles were approved.

The mileage improved with Federal aid consists of 110.4 miles of graded and drained earth roads, 3.3 miles of bituminous macadam, 8.1 miles of bituminous concrete, 1,394.4 miles of Portland-cement concrete, and 25.8 miles of brick, in addition to which there are bridges with a total length of 1.4 miles.

The total cost of all Federal-aid roads completed, including 28.2 miles of stage construction, was $48,898,354.53, of which the Federal share was $22,958,520.84. The disbursement of Federal funds to the State was $2,427,392.92. This added to the disbursements made during previous years and subtracted from the State's total apportionment of $32,986,627, leaves a balance of $8,012,418.05 unexpended funds to the credit of the State.

INDIANA

The Federal-aid highway system includes 4,701.5 miles, of which 841.5 miles have been improved with Federal aid. Of the improved mileage, 154.3 miles were added during the year. At the close of the year 367.9 miles were under construction and 68.8 miles were approved.

The mileage improved with Federal aid consists of 17 miles of graded and drained earth roads, 33.5 miles of gravel, 56.7 miles of water-bound macadam, 17 miles of bituminous macadam, 12 miles of bituminous concrete, and 702.3 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.9 miles.

The total cost of all Federal-aid roads completed, including 11.6 miles of stage construction, was $27,496,654.62, of which the Federal share was $13,147,848.20. The disbursement of Federal funds to the State was $2,055,735.74. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $20,131,127, leaves a balance of $4,570,362.18 unexpended funds to the credit of the State.

IOWA

The Federal-aid highway system includes 7,212 miles, of which 2,592.6 miles have been improved with Federal aid. Of the improved mileage, 415.6 miles were added during the year. At the close of the year 456.6 miles were under construction and 44.1 miles were approved.

The mileage improved with Federal aid consists of 1,469 miles of graded and drained earth roads, 586.4 miles of gravel, 514 miles of Portland-cement concrete, and 22 miles of brick, in addition to which there are bridges with a total length of 1.2 miles.

The total cost of all Federal-aid roads completed, including 130.2 miles of stage construction, was $36,686,963.96, of which the Federal share was $15,507,575.57. The disbursement of Federal funds to the State was $2,845,968.50. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $21,530,562, leaves a balance of $4,882,751.15 unexpended funds to the credit of the State.

KANSAS

The Federal-aid highway system includes 7,892 miles, of which 1,624.7 miles have been improved with Federal aid. Of the improved mileage, 361.1 miles were added during the year. At the close of the year 555.1 miles were under construction and 167 miles were approved.

The mileage improved with Federal aid consists of 562.1 miles of graded and drained earth roads, 135.7 miles of sand-clay, 198 miles of gravel, 4.5 miles of water-bound macadam, 97.7 miles of bituminous macadam, 3.4 miles of bituminous concrete, 479.3 miles of Portland-cement concrete, and 134.4 miles of brick, in addition to which there are bridges with a total length of 9.2 miles.

The total cost of all Federal-aid roads completed, including 27 miles of stage construction, was $40,056,652.74, of which the Federal share was $15,781,141.51. The disbursement of Federal funds to the State was $2,730,002.55. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $21,532,943, leaves a balance of $4,130,152.52 unexpended funds to the credit of the State.

KENTUCKY

The Federal-aid highway system includes 3,702.5 miles, of which 898 miles have been improved with Federal aid. Of the improved mileage, 110.6 miles were added during the year. At the close of the year 393.4 miles were under construction and 42.8 miles were approved.

The mileage improved with Federal aid consists of 411.2 miles of graded and drained earth roads, 160.6 miles of gravel, 41.4 miles of water-bound macadam, 153.4 miles of bituminous macadam, 126.9 miles of Portland-cement concrete, and 3.9 miles of brick, in addition to which there are bridges with a total length of 0.6 mile.

The total cost of all Federal-aid roads completed, including 111.3 miles of stage construction, was $24,510,594.46, of which the Federal share was $10,092,978.19. The disbursement of Federal funds to the State was $1,420,029.31. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $1,463,756, leaves a balance of $3,300,565.05 unexpended funds to the credit of the State.

LOUISIANA

The Federal-aid highway system includes 2,722.8 miles, of which 1,214.5 miles have been improved with Federal aid. Of the improved mileage, 144.7 miles were added during the year. At the close of the year 105.1 miles were under construction and 0.9 mile was approved.

The mileage improved with Federal aid consists of 25.2 miles of graded and drained earth roads, 1,152.1 miles of gravel, 3.2 miles of water-bound macadam, 9.5 miles of bituminous macadam, 10.4 miles of bituminous concrete, and 10.7 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 3.5 miles.

The total cost of all Federal-aid roads completed, including 4 miles of stage construction, was $16,906,801.67, of which the Federal share was $7,588,692.38. The disbursement of Federal funds to the State was $1,124,562.53. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $10,285,716, leaves a balance of $2,127,187.13 unexpended funds to the credit of the State.

MAINE

The Federal-aid highway system includes 1,393.5 miles, of which 362.8 miles have been improved with Federal aid. Of the improved mileage, 59.2 miles were added during the year. At the close of the year 69.6 miles were under construction and 5.6 miles were approved.

The mileage improved with Federal aid consists of 156 miles of gravel, 155.3 miles of bituminous macadam, and 51.4 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 0.2 mile.

The total cost of all Federal-aid roads completed was $10,663,734.80, of which the Federal share was $4,907,920.04. The disbursement of Federal funds to the State was $878,953.95. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $7,145,622, leaves a balance of $1,760,547.37 unexpended funds to the credit of the State.

MARYLAND

The Federal-aid highway system includes 1,503.7 miles, of which 481.8 miles have been improved with Federal aid. Of the improved mileage, 58.5 miles were added during the year. At the close of the year 29.9 miles were under construction and 66.6 miles were approved.

The mileage improved with Federal aid consists of 4.7 miles of graded and drained earth roads, 31.5 miles of gravel, 0.1 mile of water-bound macadam, 152.6 miles of bituminous macadam, 17 miles of bituminous concrete, and 276 miles of Portland-cement concrete.

The total cost of all Federal-aid roads completed was $11,924,475.65, of which the Federal share was $5,584,458.27. The disbursement of Federal funds to the State was $650,106.91. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $6,560,176, leaves a balance of $763,972.12 unexpended funds to the credit of the State.

MASSACHUSETTS

The Federal-aid highway system includes 1,308 miles, of which 440.7 miles have been improved with Federal aid. Of the improved mileage, 55 miles were added during the year. At the close of the year 62.6 miles were under construction and 2.3 miles were approved.

The mileage improved with Federal aid consists of 3.5 miles of water-bound macadam, 227.7 miles of bituminous macadam, 36.8 miles of bituminous concrete, and 168.2 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 4.3 miles.

The total cost of all Federal-aid roads completed was $22,960,850.63, of which the Federal share was $7,959,329.39. The disbursement of Federal funds to the State was $799,464.35. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $11,197,826, leaves a balance of $3,604,233.03 unexpended funds to the credit of the State.

MICHIGAN

The Federal-aid highway system includes 5,235 miles, of which 1,161.5 miles have been improved with Federal aid. Of the improved mileage, 165.9 miles were added during the year. At the close of the year 288 miles were under construction and 26.3 miles were approved.

The mileage improved with Federal aid consists of 0.5 mile of graded and drained earth roads, 329.9 miles of gravel, 18.9 miles of water-bound macadam, 10.4 miles of bituminous macadam, 73.5 miles of bituminous concrete, 727.7 miles of Portland-cement concrete, and 0.4 mile of brick, in addition to which there are bridges with a total length of 0.4 mile.

The total cost of all Federal-aid roads completed, including 42.4 miles of stage construction, was $34,875,126.43, of which the Federal share was $15,628,180.61. The disbursement of Federal funds to the State was $2,692,098.35. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $22,557,056, leaves a balance of $5,201,602.96 unexpended funds to the credit of the State.

MINNESOTA

The Federal-aid highway system includes 6,849.6 miles, of which 3,643.5 miles have been improved with Federal aid. Of the improved mileage, 394.3 miles were added during the year. At the close of the year 370 miles were under construction and 19.4 miles were approved.

The mileage improved with Federal aid consists of 490 miles of graded and drained earth roads, 6.2 miles of sand-clay, 2,630.1 miles of gravel, 32.6 miles of bituminous concrete, and 483.9 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 0.6 mile.

The total cost of all Federal-aid roads completed, including 296.1 miles of stage construction, was $45,099,-648.47, of which the Federal share was $19,046,145.67. The disbursement of Federal funds to the State was $2,590,339.01. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $21,712,521, leaves a balance of $2,189,305.45 unexpended funds to the credit of the State.

MISSISSIPPI

The Federal-aid highway system includes, 3,604 miles, of which 1,376.7 miles have been improved with Federal aid. Of the improved mileage, 217.8 miles were added during the year. At the close of the year 301.1 miles were under construction and 65.2 miles were approved.

The mileage improved with Federal aid consists of 213.9 miles of graded and drained earth roads, 21.5 miles of sand-clay, 976.6 miles of gravel, 11.1 miles of water-bound macadam, 1 mile of bituminous macadam, 9.5 miles of bituminous concrete, 133.1 miles of Portland-cement concrete, and 9.2 miles of brick, in addition to which there are bridges with a total length of 0.6 mile.

The total cost of all Federal-aid roads completed, including 58 miles of stage construction, was $19,036,438.71, of which the Federal share was $9,356,898.57. The disbursement of Federal funds to the State was $1,589,120.64. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $13,435,897, leaves a balance of $2,726,597.67 unexpended funds to the credit of the State.

MISSOURI

The Federal-aid highway system includes 7,530 miles, of which 2,077.6 miles have been improved with Federal aid. Of the improved mileage, 281.9 miles were added during the year. At the close of the year 134 miles were under construction and 68.4 miles were approved.

The mileage improved with Federal aid consists of 340 miles of graded and drained earth roads, 867.4 miles of gravel, 13.4 miles of water-bound macadam, 50.9 miles of bituminous macadam, 17.8 miles of bituminous concrete, 757.7 miles of Portland-cement concrete, and 20.9 miles of brick, in addition to which there are bridges with a total length of 9.1 miles.

The total cost of all Federal-aid roads completed, including 69.7 miles of stage construction, was $47,057,-985.96, of which the Federal share was $21,442,541.23. The disbursement of Federal funds to the State was $4,099,-338.56. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $25,191,611, leaves a balance of $4,295,198.35 unexpended funds to the credit of the State.

MONTANA

The Federal-aid highway system includes 4,665 miles, of which 1,161.8 miles have been improved with Federal aid. Of the improved mileage, 90.3 miles were added during the year. At the close of the year 119.6 miles were under construction and 305.9 miles were approved.

The mileage improved with Federal aid consists of 213.1 miles of graded and drained earth roads, 5.6 miles of sand-clay, 883.7 miles of gravel, 16 miles of water-bound macadam, 6.9 miles of bituminous macadam, 2.8 miles of bituminous concrete, and 31.3 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.5 miles.

The total cost of all Federal-aid roads completed, including 71.5 miles of stage construction, was $12,937,675.16, of which the Federal share was $7,347,-567.20. The disbursement of Federal funds to the State was $894,779.83. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $14,976,384, leaves a balance of $7,198,788.68 unexpended funds to the credit of the State.

NEBRASKA

The Federal-aid highway system includes 5,569.1 miles, of which 2,651.1 miles have been improved with Federal aid. Of the improved mileage, 629.9 miles were added during the year. At the close of the year 900.6 miles were under construction and 166.6 miles were approved.

The mileage improved with Federal aid consists of 922.9 miles of graded and drained earth roads, 764.6 miles of sand-clay, 873.7 miles of gravel, 11 miles of bituminous concrete, 55 miles of Portland-cement concrete, and 18.7 miles of brick, in addition to which there are bridges with a total length of 5.3 miles.

The total cost of all Federal-aid roads completed, including 666.6 miles of stage construction, was $20,308,-791.23, of which the Federal share was $9,779,936.76. The disbursement of

Federal funds to the State was $2,370,258.28. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $16,220,373, leaves a balance of $4,986,183.13 unexpended funds to the credit of the State.

NEVADA

The Federal-aid highway system includes 1,398 miles, of which 940.7 miles have been improved with Federal aid. Of the improved mileage, 230.6 miles were added during the year. At the close of the year 95.6 miles were under construction.

The mileage improved with Federal aid consists of 40.6 miles of graded and drained earth roads, 26.4 miles of sand-clay, 792.9 miles of gravel, 10.2 miles of water-bound macadam, 20.6 miles of bituminous macadam, 2 miles of bituminous concrete, and 44.9 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 3.3 miles.

The total cost of all Federal-aid roads completed, including 76 miles of stage construction, was $11,049,750.51, of which the Federal share was $8,133,489.64. The disbursement of Federal funds to the State was $1,083,652.86. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $9,743,725, leaves a balance of $1,166,710.95 unexpended funds to the credit of the State.

NEW HAMPSHIRE

The Federal-aid highway system includes 980.9 miles, of which 268.5 miles have been improved with Federal aid. Of the improved mileage, 23.9 miles were added during the year. At the close of the year 27.1 miles were under construction and 8.8 miles were approved.

The mileage improved with Federal aid consists of 99.1 miles of gravel, 53.8 miles of water-bound macadam, 72.5 miles of bituminous macadam, 32.6 miles of bituminous concrete, and 7.7 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.6 miles.

The total cost of all Federal-aid roads completed was $5,966,371.13, of which the Federal share was $2,827,664.73. The disbursement of Federal funds to the State was $424,768.85. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $3,535,117, leaves a balance of $628,734.92 unexpended funds to the credit of the State.

NEW JERSEY

The Federal-aid highway system includes 1,198.3 miles, of which 345.1 miles have been improved with Federal aid. Of the improved mileage, 37.2 miles were added during the year. At the close of the year 82.5 miles were under construction and 5.9 miles were approved.

The mileage improved with Federal aid consists of 6.2 miles of graded and drained earth roads, 0.8 mile of sand-clay, 3.8 miles of gravel, 21.9 miles of bituminous concrete, and 310.1 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.3 miles.

The total cost of all Federal-aid roads completed was $24,357,307.14, of which the Federal share was $7,939,988.87. The disbursement of Federal funds to the State was $732,592.69. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $9,402,031, leaves a balance of $1,906,666.52 unexpended funds to the credit of the State.

NEW MEXICO

The Federal-aid highway system includes 3,298 miles, of which 1,560.3 miles have been improved with Federal aid. Of the improved mileage 69.8 miles were added during the year. At the close of the year 178.5 miles were under construction.

The mileage improved with Federal aid consists of 243.4 miles of graded and drained earth roads, 5.1 miles of sand-clay, 1,239.4 miles of gravel, 0.7 mile of bituminous concrete, and 70.1 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 1.6 miles.

The total cost of all Federal-aid roads completed, including 93 miles of stage construction, was $13,993,014.03, of which the Federal share was $8,401,600.54. The disbursement of Federal funds to the State was $1,110,390.27. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $12,159,149, leaves a balance of $3,173,897.80 unexpended funds to the credit of the State.

NEW YORK

The Federal-aid highway system includes 5,018 miles, of which 1,479.8 miles have been improved with Federal aid. Of the improved mileage 248 miles were added during the year. At the close of the year 539.3 miles were under construction and 155.6 miles were approved.

The mileage improved with Federal aid consists of 2.4 miles of graded and drained earth roads, 22.8 miles of gravel, 345.1 miles of bituminous macadam, 11.5 miles of bituminous concrete, 1,096 miles of Portland-cement concrete, and 0.7 mile of brick, in addition to which there are bridges with a total length of 1.5 miles.

The total cost of all Federal-aid roads completed was $56,632,985.44, of which the Federal share was $22,425,513.15. The disbursement of Federal funds to the State was $4,367,134.87. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $37,680,412, leaves a balance of $12,635,971.33 unexpended funds to the credit of the State.

NORTH CAROLINA

The Federal-aid highway system includes 3,860.8 miles, of which 1,489 miles have been improved with Federal aid. Of the improved mileage 145.9 miles were added during the year. At the close of the year 58.7 miles were under construction and 36.8 miles were approved.

The mileage improved with Federal aid consists of 89.6 miles of graded and drained earth roads, 521.1 miles of sand-clay, 70.9 miles of gravel, 19.6 miles of water-bound macadam, 37.9 miles of bituminous macadam 249.4 miles of bituminous concrete, and 498.3 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.1 miles.

The total cost of all Federal-aid roads completed, including 91.8 miles of stage construction, was $36,025,574.41, of which the Federal share was $14,869,283.31. The disbursement of Federal funds to the State was $2,441,688.30. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $17,430,562, leaves a balance of $2,114,184.48 unexpended funds to the credit of the State.

NORTH DAKOTA

The Federal-aid highway system includes 7,194 miles, of which 2,851.7 miles have been improved with Federal aid. Of the improved mileage 576 miles were added during the year. At the close of the year 602.8 miles were under construction and 320.8 miles were approved.

The mileage improved with Federal aid consists of 1,458.6 miles of graded and drained earth roads, 25.1 miles of sand-clay, 1,354.3 miles of gravel, 1 mile of water-bound macadam, 1.9 miles of bituminous concrete, and 4.7 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 6 miles.

The total cost of all Federal-aid roads completed, including 840.8 miles of stage construction, was $16,716,504.05, of which the Federal share was $8,225,349.31. The disbursement of Federal funds to the State was $2,530,261.21. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $11,943,610, leaves a balance of $2,612,640.08 unexpended funds to the credit of the State.

OHIO

The Federal-aid highway system includes 5,899.3 miles, of which 1,550.7 miles have been improved with Federal aid. Of the improved mileage 128.1 miles were added during the year. At the close of the year 298.6 miles were under construction and 20.8 miles were approved.

The mileage improved with Federal aid consists of 41.2 miles of graded and drained earth roads, 6.7 miles of gravel, 103.3 miles of water-bound macadam, 320.1 miles of bituminous macadam, 93.8 miles of bituminous concrete, 539.9 miles of Portland-cement concrete, and 444.9 miles of brick, in addition to which there are bridges with a total length of 0.7 mile.

The total cost of all Federal-aid roads completed, including 34.6 miles of stage construction, was $53,799,465.23, of which the Federal share was $19,827,851.84. The disbursement of Federal funds to the State was $2,580,502.50. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $28,494,005, leaves a balance of $6,740,945.60 unexpended funds to the credit of the State.

OKLAHOMA

The Federal-aid highway system includes 5,528 miles, of which 1,384.5 miles have been improved with Federal aid. Of the improved mileage, 183 miles were added during the year. At the close of the year 134.8 miles were under construction and 71.5 miles were approved.

The mileage improved with Federal aid consists of 219.8 miles of graded and drained earth roads, 2.3 miles of sand-clay, 605.6 miles of gravel, 6.3 miles of water-bound macadam, 8.4 miles of bituminous macadam, 78.4 miles of bituminous concrete, 443 miles of Portland-cement concrete, and 8.9 miles of brick, in addition to which there are bridges with a total length of 11.5 miles.

The total cost of all Federal-aid roads completed, including 23.2 miles of stage construction, was $32,242,-064.54, of which the Federal share was $14,883,940.46. The disbursement of Federal funds to the State was $1,339,-252.44. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $17,811,678, leaves a balance of $2,812,013.26 unexpended funds to the credit of the State.

OREGON

The Federal-aid highway system includes 2,814 miles, of which 1,055.2 miles have been improved with Federal aid. Of the improved mileage, 93.6 miles were added during the year. At the close of the year 62.2 miles were under construction and 9.9 miles were approved.

The mileage improved with Federal aid consists of 145.3 miles of graded and drained earth roads, 728 miles of gravel, 25.6 miles of water-bound macadam, 0.8 mile of bituminous macadam, 52.9 miles of bituminous concrete, and 99.8 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.8 miles.

The total cost of all Federal-aid roads completed, including 23 miles of stage construction, was $19,750,647.26, of which the Federal share was $10,141,-690.44. The disbursement of Federal funds to the State was $1,301,855.33. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $12,061,549, leaves a balance of $1,311,677.28 unexpended funds to the credit of the State.

PENNSYLVANIA

The Federal-aid highway system includes 4,602.1 miles, of which 1,639.5 miles have been improved with Federal aid. Of the improved mileage, 204.3 miles were added during the year. At the close of the year 217.9 miles were under construction and 64.2 miles were approved.

The mileage improved with Federal aid consists of 89.7 miles of graded and drained earth roads, 7.8 miles of bituminous macadam, 101.2 miles of bituminous concrete, 1,414.2 miles of Portland-cement concrete, and 26.4 miles of brick.

The total cost of all Federal-aid roads completed was $83,038,333.31, of which the Federal share was $27,819,175.23. The disbursement of Federal funds to the State was $3,180,313.25. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $34,674,516 leaves a balance of $6,-066,283.78 unexpended funds to the credit of the State.

RHODE ISLAND

The Federal-aid highway system includes 356.9 miles, of which 118.2 miles have been improved with Federal aid. Of the improved mileage, 23.9 miles were added during the year. At the close of the year 20.4 miles were under construction and 9.3 miles were approved.

The mileage improved with Federal aid consists of 1.8 miles of water-bound macadam, 17.4 miles of bituminous macadam, 47.3 miles of bituminous concrete, and 51.6 miles of Portland-cement concrete.

The total cost of all Federal-aid roads completed was $5,326,208.94, of which the Federal share was $2,030,654.06 The disbursement of Federal funds to the State was $466,586.24. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $3,-033,194 leaves a balance of $1,007,-778.70 unexpended funds to the credit of the State.

SOUTH CAROLINA

The Federal-aid highway system includes 3,230 miles, of which 1,639.2 miles have been improved with Federal aid. Of the improved mileage, 102.3 miles were added during the year. At the close of the year 165 miles were under construction and 22.9 miles were approved.

The mileage improved with Federal aid consists of 40.5 miles of graded and drained earth roads, 1,289.6 miles of sand-clay, 115.6 miles of gravel, 8.9 miles of water-bound macadam, 3 miles of bituminous macadam, 89 miles of bituminous concrete, 81.4 miles of Portland-cement concrete, and 0.2 mile of brick, in addition to which there are bridges with a total length of 10.9 miles.

The total cost of all Federal-aid roads completed, including 45.6 miles of stage construction, was $19,448,-510.98, of which the Federal share was $8,712,260.60. The disbursement of Federal funds to the State was $1,187,023.41. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $10,856,512, leaves a balance of $1,421,754.67 unexpended funds to the credit of the State.

SOUTH DAKOTA

The Federal-aid highway system includes 5,747 miles, of which 2,618.1 miles have been improved with Federal

aid. Of the improved mileage, 372.3 miles were added during the year. At the close of the year 508.4 miles were under construction and 131.5 miles were approved.

The mileage improved with Federal aid consists of 495.1 miles of graded and drained earth roads, 18.2 miles of sand-clay, 2,101.5 miles of gravel, and 1.2 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.1 miles.

The total cost of all Federal-aid roads completed, including 278.9 miles of stage construction, was $19,735,-884.45, of which the Federal share was $9,758,202.41. The disbursement of Federal funds to the State was $1,074,-687.39. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $12,386,854, leaves a balance of $1,942,005.03 unexpended funds to the credit of the State.

TENNESSEE

The Federal-aid highway system includes 3,252.8 miles, of which 975.4 miles have been improved with Federal aid. Of the improved mileage, 140.1 miles were added during the year. At the close of the year 119 miles were under construction.

The mileage improved with Federal aid consists of 149.4 miles of graded and drained earth roads, 117 miles of gravel, 52.2 miles of water-bound macadam, 416.2 miles of bituminous macadam, 27.7 miles of bituminous concrete, and 211.2 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 1.6 miles.

The total cost of all Federal-aid roads completed, including 52 miles of stage construction, was $28,556,-694.76, of which the Federal share was $13,448,035.73. The disbursement of Federal funds to the State was $1,793,-804.55. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $16,895,357, leaves a balance of $3,024,467.64 unexpended funds to the credit of the State.

TEXAS

The Federal-aid highway system includes 11,404.7 miles, of which 5,658.2 miles have been improved with Federal aid. Of the improved mileage, 602.4 miles were added during the year. At the close of the year 343.3 miles were under construction and 54.7 miles were approved.

The mileage improved with Federal aid consists of 795 miles of graded and drained earth roads, 83.9 miles of sand-clay, 2,963 miles of gravel, 527 miles of water-bound macadam, 622.4 miles of bituminous macadam, 120.6 miles of bituminous concrete, 509.2 miles of Portland-cement concrete, and 29.2 miles of brick, in addition to which there are bridges with a total length of 8 miles.

The total cost of all Federal-aid roads completed, including 181.1 miles of stage construction, was $84,133,-673.64, of which the Federal share was $34,164,583.64. The disbursement of Federal funds to the State was $4,710,-228.42. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $45,103,703, leaves a balance of $8,982,385.50 unexpended funds to the credit of the State.

UTAH

The Federal-aid highway system includes 1,677.3 miles, of which 721.1 miles have been improved with Federal aid. Of the improved mileage, 98.5 miles were added during the year. At the close of the year 81.3 miles were under construction and 37.6 miles were approved.

The mileage improved with Federal aid consists of 94.3 miles of graded and drained earth roads, 41.7 miles of sand-clay, 472.1 miles of gravel, 9.3 miles of water-bound macadam, 0.7 mile of bituminous macadam, 9.9 miles of bituminous concrete, and 91.6 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 1.7 miles.

The total cost of all Federal-aid roads completed was $10,182,174.78, of which the Federal share was $6,550,122.70. The disbursement of Federal funds to the State was $830,082.69. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $8,665,685, leaves a balance of $1,806,-840.29 unexpended funds to the credit of the State.

VERMONT

The Federal-aid highway system includes 1,043 miles, of which 160.5 miles have been improved with Federal aid. Of the improved mileage, 25.3 miles were added during the year. At the close of the year 33.9 miles were under construction and 27.4 miles were approved.

The mileage improved with Federal aid consists of 99.8 miles of gravel, 3.5 miles of water-bound macadam, 30.1 miles of bituminous macadam, and 21.2 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 5.8 miles.

The total cost of all Federal-aid roads completed was $5,485,007.14, of which the Federal share was $2,545,061.70. The disbursement of Federal funds to the State was $625,423.73. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $3,634,132, leaves a balance of $847,317.80 unexpended funds to the credit of the State.

VIRGINIA

The Federal-aid highway system includes 3,233 miles, of which 1,182.8 miles have been improved with Federal aid. Of the improved mileage, 132.7 miles were added during the year. At the close of the year 95.5 miles were under construction and 19 miles were approved.

The mileage improved with Federal aid consists of 58.9 miles of graded and drained earth roads, 212.5 miles of sand-clay, 121.6 miles of gravel, 108.6 miles of water-bound macadam, 303.5 miles of bituminous macadam, 10.6 miles of bituminous concrete, and 364.7 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.4 miles.

The total cost of all Federal-aid roads completed was $27,331,674.40, of which the Federal share was $12,756,334.06. The disbursement of Federal funds to the State was $1,868,896.29. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $14,944,228, leaves a balance of $1,674,225.98 unexpended funds to the credit of the State.

WASHINGTON

The Federal-aid highway system includes 2,927.5 miles, of which 722.2 miles have been improved with Federal aid. Of the improved mileage, 53.6 miles were added during the year. At the close of the year 57.1 miles were under construction and 10.1 miles were approved.

The mileage improved with Federal aid consists of 125.8 miles of graded and drained earth roads. 321.1 miles of gravel, and 273.2 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 2.1 miles.

The total cost of all Federal-aid roads completed, including 14.2 miles of stage construction, was $18,541,646.53, of which the Federal share was $8,411,551.95. The disbursement of Federal funds to the State was $1,146,672.36. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $11,277,308, leaves a balance of $1,792,635.87 unexpended funds to the credit of the State.

WEST VIRGINIA

The Federal-aid highway system includes 2,000.6 miles, of which 474.2 miles have been improved with Federal aid. Of the improved mileage, 59.7 miles were added during the year. At the close of the year 183.4 miles were under construction and 26.9 miles were approved.

The mileage improved with Federal aid consists of 164.8 miles of graded and drained earth roads, 5.6 miles of sand-clay, 18.2 miles of gravel, 4.9 miles of water-bound macadam, 124.5 miles of bituminous macadam, 21.3 miles of bituminous concrete, 123.1 miles of Portland-cement concrete, and 11.4 miles of brick, in addition to which there are bridges with a total length of 0.5 mile.

The total cost of all Federal-aid roads completed, including 21.1 miles of stage construction, was $12,413,729.68, of which the Federal share was $5,373,686.14. The disbursement of Federal funds to the State was $648,202.63. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $8,146,147, leaves a balance of $2,032,300.56 unexpended funds to the credit of the State.

WISCONSIN

The Federal-aid highway system includes 5,493.3 miles, of which 1,748.6 miles have been improved with Federal aid. Of the improved mileage, 129.5 miles were added during the year. At the close of the year 356.4 miles were under construction and 19.4 miles were approved.

The mileage improved with Federal aid consists of 206 miles of graded and drained earth roads, 115.5 miles of sand-clay, 920.8 miles of gravel, 2.7 miles of water-bound macadam, 13.8 miles of bituminous macadam, and 488.5 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 1.4 miles.

The total cost of all Federal-aid roads completed, including 88.7 miles of stage construction, was $28,360,984.81, of which the Federal share was $12,068,823.90. The disbursement of Federal funds to the State was $2,357,068.54. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $19,309,270, leaves a balance of $5,645,332.47 unexpended funds to the credit of the State.

WYOMING

The Federal-aid highway system includes 3,097 miles, of which 1,350.2 miles have been improved with Federal aid. Of the improved mileage, 125.1 miles were added during the year. At the close of the year 143.2 miles were under construction.

The mileage improved with Federal aid consists of 405.6 miles of graded and drained earth roads, 485.4 miles of sand-clay, 418 miles of gravel, 22.1 miles of bituminous concrete, and 14.8 miles of Portland-cement concrete, in addition to which there are bridges with a total length of 4.1 miles.

The total cost of all Federal-aid roads completed, including 98.6 miles of stage construction, was $13,684,719.82, of which the Federal share was $7,816,311.16. The disbursement of Federal funds to the State was $696,804.42. This, added to the disbursements made during previous years and subtracted from the State's total apportionment of $9,500,643, leaves a balance of $1,568,534.67 unexpended funds to the credit of the State.

FEDERAL-AID STATISTICS

Complete statistics for the Federal-aid roads completed during the year and during the entire period since the passage of the Federal-aid road act of 1916, with reference to the mileage and type of roads constructed, their total cost, and Federal-aid allotments, etc., are given in Tables 9 to 19, inclusive.

TABLE 9.—*Total cost, Federal aid and mileage of Federal-aid roads, original and stage construction, completed during the fiscal year 1927, by States*

State	Total cost	Federal aid	Miles (original)	Miles (stage)
Alabama	$1,642,397.27	$794,616.21	78.3	4.6
Arizona	759,421.93	499,941.68	68.6	.4
Arkansas	2,380,855.89	1,132,085.21	168.9	----------
California	7,355,463.61	3,717,364.67	195.6	17.3
Colorado	2,958,510.73	1,468,361.60	166.6	----------
Connecticut	1,634,561.20	417,833.05	24.0	----------
Delaware	1,432,385.36	620,612.37	40.2	----------
Florida	2,402,385.61	1,133,408.48	65.9	----------
Georgia	8,318,990.63	3,992,430.39	394.3	63.3
Idaho	2,379,468.83	1,344,143.69	177.0	13.1
Illinois	2,259,678.01	1,080,098.80	76.3	2.0
Indiana	4,899,996.16	2,247,501.37	154.3	11.6
Iowa	6,495,281.14	3,074,642.42	415.6	74.3
Kansas	5,610,039.92	2,425,016.73	361.1	.1
Kentucky	3,191,460.09	1,350,461.54	110.6	14.6
Louisiana	2,624,942.63	1,229,355.95	144.7	----------
Maine	1,916,182.04	715,412.65	59.2	----------
Maryland	999,532.55	471,467.05	58.5	----------
Massachusetts	3,743,211.50	1,060,946.19	55.0	----------
Michigan	7,520,266.98	3,153,877.40	165.7	25.7
Minnesota	7,248,884.52	3,133,529.11	394.3	114.6
Mississippi	3,319,730.75	1,657,054.77	217.8	----------
Missouri	9,486,643.42	4,152,613.71	281.9	29.6
Montana	1,023,396.10	740,036.65	90.3	62.6
Nebraska	5,929,773.22	2,911,147.90	629.9	238.6
Nevada	1,734,244.90	1,473,599.53	230.6	11.0
New Hampshire	705,801.62	317,313.41	23.9	----------
New Jersey	6,676,462.88	2,561,536.50	37.2	----------
New Mexico	792,954.91	550,442.63	69.8	----------
New York	11,175,905.65	3,799,425.96	248.0	----------
North Carolina	5,336,143.65	2,127,764.59	145.9	37.5
North Dakota	3,203,927.76	1,622,360.21	576.0	362.9
Ohio	4,431,814.99	1,753,398.02	128.1	13.4
Oklahoma	3,326,117.61	1,399,083.88	183.0	10.1
Oregon	2,137,788.85	1,196,486.51	93.6	----------
Pennsylvania	8,226,260.64	2,712,208.40	204.3	----------
Rhode Island	1,006,002.25	357,750.00	23.9	----------
South Carolina	2,259,842.16	932,884.49	102.3	15.4
South Dakota	1,545,292.60	809,569.76	272.3	154.4
Tennessee	5,415,909.15	2,452,111.40	140.1	19.1
Texas	12,730,327.00	5,703,444.94	602.4	39.8
Utah	1,127,941.98	859,078.73	98.5	----------
Vermont	1,211,037.88	516,577.19	25.3	----------
Virginia	3,921,183.08	1,783,765.41	132.7	----------
Washington	1,463,134.90	628,642.49	53.6	----------
West Virginia	2,155,588.48	882,257.48	59.7	----------
Wisconsin	3,007,950.61	1,430,427.17	129.5	7.8
Wyoming	1,301,331.74	838,829.53	125.1	32.8
Hawaii	343,664.15	97,440.00	6.5	----------
Total	182,770,089.53	81,330,357.82	8,306.9	1,376.6

TABLE 10.—*Total cost, Federal aid and mileage of Federal-aid roads completed to June 30, 1927, by States*

State	Total cost	Federal aid	Miles [1]
Alabama	$22,394,983.26	$10,678,040.69	1,494.0
Arizona	12,288,747.00	6,750,136.37	835.7
Arkansas	22,638,788.64	9,675,983.97	1,587.4
California	37,590,843.42	18,275,993.48	1,365.3
Colorado	18,184,354.89	9,269,990.10	963.6
Connecticut	7,612,390.21	2,691,696.71	151.1
Delaware	6,350,437.65	2,402,277.97	164.5
Florida	10,391,903.41	5,011,696.35	315.6
Georgia	36,023,188.89	17,101,498.97	2,369.8
Idaho	14,160,210.06	7,669,247.11	950.7
Illinois	48,898,354.53	22,958,520.84	1,543.4
Indiana	27,496,654.62	13,147,848.20	841.5
Iowa	36,686,963.96	15,507,575.57	2,592.6
Kansas	40,056,652.74	15,781,141.51	1,624.7
Kentucky	24,510,594.46	10,092,978.19	898.0
Louisiana	16,906,801.67	7,588,692.38	1,214.5
Maine	10,663,734.80	4,907,920.04	362.8
Maryland	11,924,475.65	5,584,458.27	481.8
Massachusetts	22,960,850.63	7,959,329.39	440.7
Michigan	34,875,126.43	15,628,180.61	1,161.5
Minnesota	45,099,648.47	19,046,145.67	3,643.5
Mississippi	19,036,438.71	9,356,898.57	1,376.7
Missouri	47,057,985.96	21,442,541.23	2,077.6
Montana	12,937,675.16	7,347,567.20	1,161.8
Nebraska	20,308,791.23	9,779,936.76	2,651.1
Nevada	11,049,750.51	8,133,489.64	940.7
New Hampshire	5,966,371.13	2,827,664.73	268.5
New Jersey	24,357,307.14	7,939,988.87	345.1
New Mexico	13,993,014.03	8,401,600.54	1,560.3
New York	56,632,985.44	22,425,513.15	1,479.8
North Carolina	36,025,574.41	14,869,283.31	1,489.0
North Dakota	16,716,504.05	8,225,349.31	2,851.7
Ohio	53,799,465.23	19,827,851.84	1,550.7
Oklahoma	32,242,064.54	14,883,940.46	1,384.5
Oregon	19,750,647.26	10,141,690.44	1,055.2
Pennsylvania	83,038,333.31	27,819,175.23	1,639.5
Rhode Island	5,326,208.94	2,030,654.06	118.2
South Carolina	19,448,510.98	8,712,260.60	1,639.2
South Dakota	19,735,884.45	9,758,202.41	2,618.1
Tennessee	28,556,694.76	13,448,035.73	975.4
Texas	84,133,673.64	34,164,583.64	5,658.2
Utah	10,182,174.78	6,550,122.70	721.1
Vermont	5,485,007.14	2,545,061.70	160.5
Virginia	27,331,674.40	12,756,334.06	1,182.8
Washington	18,541,646.53	8,411,551.95	722.2
West Virginia	12,413,729.68	5,373,686.14	474.2
Wisconsin	28,360,984.81	12,068,823.90	1,748.6
Wyoming	13,684,719.82	7,816,311.16	1,350.2
Hawaii	343,664.15	97,440.00	6.5
Total	1,234,173,187.58	544,884,911.72	64,209.7

[1] Mileage is of original improvement only.

TABLE 11.—*Total program as of June 30, 1927, of projects which have been approved for construction, completed, and under construction*

State	Total cost	Federal aid	Miles [1]
Alabama	$26,892,327.66	$12,874,711.93	1,795.8
Arizona	13,573,562.27	7,756,017.18	882.6
Arkansas	26,169,062.71	11,195,836.69	1,791.5
California	42,652,152.33	20,449,769.87	1,462.2
Colorado	21,824,043.72	11,028,895.64	1,108.0
Connecticut	12,958,034.68	4,212,119.89	214.2
Delaware	7,397,224.63	2,791,815.99	203.4
Florida	17,523,370.46	7,923,638.69	465.6
Georgia	40,239,287.71	19,190,898.09	2,507.6
Idaho	16,092,498.85	8,855,522.64	1,043.9
Illinois	64,033,039.12	30,283,916.57	2,073.6
Indiana	41,337,877.45	19,752,019.30	1,278.2
Iowa	50,125,904.34	21,380,719.11	3,093.1
Kansas	53,458,554.93	21,056,443.28	2,346.8
Kentucky	33,447,506.06	14,346,680.12	1,334.2
Louisiana	21,139,869.20	9,338,158.64	1,320.5
Maine	13,539,961.13	5,895,203.10	438.0
Maryland	13,992,821.63	6,472,928.91	578.3
Massachusetts	26,830,477.64	9,001,408.84	505.6
Michigan	45,044,065.43	20,321,953.34	1,475.8
Minnesota	52,696,131.59	21,162,044.57	4,032.9
Mississippi	25,857,554.89	12,658,131.29	1,743.0
Missouri	53,105,121.82	24,202,844.57	2,280.9
Montana	17,727,900.08	10,589,158.05	1,587.3
Nebraska	31,151,224.65	15,147,880.43	3,718.3
Nevada	11,941,462.47	8,903,528.35	1,036.3
New Hampshire	7,247,059.04	3,392,317.74	304.4
New Jersey	30,186,703.57	9,284,383.04	433.5
New Mexico	16,675,155.12	10,524,013.28	1,738.8
New York	102,623,971.44	33,579,477.10	2,174.7
North Carolina	39,421,253.17	16,464,798.83	1,584.5
North Dakota	22,962,132.22	11,503,422.80	3,775.3
Ohio	65,061,641.92	24,142,358.08	1,870.1
Oklahoma	35,443,999.66	16,317,269.06	1,590.8
Oregon	22,081,219.74	11,343,219.92	1,127.3
Pennsylvania	97,156,742.34	32,454,985.56	1,921.6
Rhode Island	7,098,907.42	2,489,872.80	147.9
South Carolina	24,037,642.52	10,455,890.20	1,827.1
South Dakota	23,540,214.78	11,814,303.22	3,258.0
Tennessee	33,075,863.23	15,166,144.62	1,694.4
Texas	94,658,795.27	38,917,998.81	6,056.2
Utah	12,053,483.28	7,954,338.21	840.0
Vermont	8,381,603.22	3,591,524.14	221.8
Virginia	32,600,170.83	14,869,554.36	1,297.3
Washington	22,112,456.42	10,062,151.95	789.4
West Virginia	18,280,061.74	7,833,676.68	684.5
Wisconsin	38,423,174.53	16,748,937.70	2,124.4
Wyoming	15,055,365.96	8,696,364.00	1,493.4
Hawaii	2,129,988.04	659,802.64	36.2
Total	1,551,058,642.91	675,059,044.82	76,708.3

[1] Mileage is of original improvement only.

TABLE 12.—*Mileage of Federal-aid roads completed during the fiscal year 1927 by types of construction*

State	Graded and drained	Sand-clay	Gravel	Water-bound mac-adam	Bitu-minous mac-adam	Bitu-minous con-crete	Port-land-cement con-crete	Brick	Bridges	Total
Alabama	44.0	0.4	12.3			6.7	14.4		0.4	78.3
Arizona	27.5	9.2	27.7			4.0			.3	68.6
Arkansas			140.3	.2	14.8	7.9	4.0		1.6	168.9
California	37.2		68.1	.6	7.3	18.6	61.4		2.2	195.6
Colorado	59.2	28.8	54.4				22.6		1.7	166.6
Connecticut			.2				23.6		.3	24.0
Delaware				5.0			35.2			40.2
Florida [1]	9.8		21.8	−6.9		18.5	22.2		.4	65.9
Georgia	90.3	150.3	77.7	24.7	17.4		31.9		2.2	394.3
Idaho	63.2	6.0	86.7			17.3	2.9		.9	177.0
Illinois							76.3			76.3
Indiana	3.0			45.1			104.8		1.4	154.3
Iowa	283.6		76.5				54.4		1.0	415.6
Kansas	249.5	23.4	17.3		13.1		39.7	11.4	6.7	361.1
Kentucky	85.6		2.5		13.6		8.5		.4	110.6
Louisiana	21.8		115.1				7.1		.7	144.7
Maine			29.3		17.9		12.1			59.2
Maryland					45.8	4.7	8.1			58.5
Massachusetts				.2	28.5		24.4		1.8	55.0
Michigan	.4		23.6				141.3		.4	165.9
Minnesota	143.0		131.3			4.8	115.2			394.3
Mississippi	77.5	.9	103.0			.3	35.9		.1	217.8
Missouri	46.1		19.8				201.8	12.5	1.7	281.9
Montana	4.1		85.8						.1	90.3
Nebraska	103.6	286.7	229.7			.7	7.4		2.1	629.9
Nevada	3.5		220.9		5.0				1.2	230.6
New Hampshire			2.7	7.3	8.6	2.6	2.6		.1	23.9
New Jersey	4.6						31.0		1.6	37.2
New Mexico [1]	17.6		58.1				−6.3		.3	69.8
New York	2.4		14.2		24.4	6.7	200.3			248.0
North Carolina	9.0					21.0	115.8		.2	145.9
North Dakota	407.8	23.5	137.6	1.0		.6	1.6		3.9	576.0
Ohio	7.6			20.7	16.9	5.7	60.7	15.9	.6	128.1
Oklahoma	126.5		9.9			13.9	30.5		2.1	183.0
Oregon	15.9		68.9				8.4		.5	93.6
Pennsylvania	56.9						147.3			204.3
Rhode Island [1]				−.1	.9	9.0	14.1			23.9
South Carolina	6.4	71.6	1.0	2.9		7.4	9.9		3.1	102.3
South Dakota	168.3		103.7						.1	272.3
Tennessee	60.8				14.5	5.8	58.9		.1	140.1
Texas [1]	211.7		104.6	36.4	149.1	−1.1	100.9		1.1	602.4
Utah			98.4						.1	98.5
Vermont			12.8		5.2		5.1		2.2	25.3
Virginia	7.1	10.3	7.7		54.6		52.1		.8	132.7
Washington	17.0		9.7				26.8		.1	53.6
West Virginia	7.4				14.5	5.0	32.8			59.7
Wisconsin			69.5		4.2		54.7		1.3	129.5
Wyoming	57.2	1.0	66.7						.1	125.1
Hawaii					6.5					6.5
Total	2,537.1	612.1	2,309.5	137.1	462.7	159.9	2,002.7	39.8	45.9	8,306.9

[1] Negative figures caused by revision of records when final vouchers were paid on projects the type of which was changed after ratification of project agreement.

TABLE 13.—*Mileage of Federal-aid roads completed to June 30, 1927, by types of construction*

State	Graded and drained	Sand-clay	Gravel	Water-bound mac-adam	Bitu-minous mac-adam	Bitu-minous con-crete	Port-land-cement con-crete	Brick	Bridges	Total
Alabama	72.3	413.2	780.9	11.6	53.2	87.5	71.9	------	3.3	1,494.0
Arizona	124.2	131.4	428.2	14.2	-------	26.6	108.5	------	2.6	835.7
Arkansas	-------	3.0	1,059.5	48.4	98.9	256.3	118.2	------	3.3	1,587.4
California	314.0	-------	348.5	18.6	63.1	85.9	530.0	------	4.9	1,365.3
Colorado	231.7	105.7	409.0	-------	-------	4.0	207.3	------	6.0	963.6
Connecticut	-------	-------	.2	8.7	27.1	-------	114.9	------	.3	151.1
Delaware	-------	-------	-------	5.0	-------	-------	153.1	6.2	.2	164.5
Florida	9.8	21.1	34.8	18.5	72.7	41.8	103.9	10.1	3.0	315.6
Georgia	166.0	1,257.7	423.3	73.1	123.1	25.9	275.2	.5	25.2	2,369.8
Idaho	228.7	22.7	591.4	4.3	4.9	61.0	35.9	------	2.0	950.7
Illinois	110.4	-------	-------	-------	3.3	8.1	1,394.4	25.8	1.4	1,543.4
Indiana	17.0	-------	33.5	56.7	17.0	12.0	702.3	------	2.9	841.5
Iowa	1,469.0	-------	586.4	-------	-------	-------	514.0	22.0	1.2	2,592.6
Kansas	562.1	135.7	198.0	4.5	97.7	3.4	479.3	134.4	9.2	1,624.7
Kentucky	411.2	-------	160.6	41.4	153.4	-------	126.9	3.9	.6	898.0
Louisiana	25.2	-------	1,152.1	3.2	9.5	10.4	10.7	------	3.5	1,214.5
Maine	-------	-------	156.0	-------	155.3	-------	51.4	------	.2	362.8
Maryland	4.7	-------	31.5	.1	152.6	17.0	276.0	------	-------	481.8
Massachusetts	-------	-------	-------	3.5	227.7	36.8	168.2	------	4.3	440.7
Michigan	.5	-------	329.9	18.9	10.4	73.5	727.7	.4	.4	1,161.5
Minnesota	490.0	6.2	2,630.1	-------	-------	32.6	483.9	------	.6	3,643.5
Mississippi	213.9	21.5	976.6	11.1	1.0	9.5	133.1	9.2	.6	1,376.7
Missouri	340.0	-------	867.4	13.4	50.9	17.8	757.7	20.9	9.1	2,077.6
Montana	213.1	5.6	883.7	16.0	6.9	2.8	31.3	------	2.5	1,161.8
Nebraska	922.9	764.6	873.7	-------	-------	11.0	55.0	18.7	5.3	2,651.1
Nevada	40.6	26.4	792.9	10.2	20.6	2.0	44.9	------	3.3	940.7
New Hampshire	-------	-------	99.1	53.8	72.5	32.6	7.7	------	2.6	268.5
New Jersey	6.2	.8	3.8	-------	-------	21.9	310.1	------	2.3	345.1
New Mexico	243.4	5.1	1,239.4	-------	-------	.7	70.1	------	1.6	1,560.3
New York	2.4	-------	22.8	-------	345.1	11.5	1,096.0	.7	1.5	1,479.8
North Carolina	89.6	521.1	70.9	19.6	37.9	249.4	498.3	------	2.1	1,489.0
North Dakota	1,458.6	25.1	1,354.3	1.0	-------	1.9	4.7	------	6.0	2,851.7
Ohio	41.2	-------	6.7	103.3	320.1	93.8	539.9	444.9	.7	1,550.7
Oklahoma	219.8	2.3	605.6	6.3	8.4	78.4	443.0	8.9	11.5	1,384.5
Oregon	145.3	-------	728.0	25.6	.8	52.9	99.8	------	2.8	1,055.2
Pennsylvania	89.7	-------	-------	-------	7.8	101.2	1,414.2	26.4	-------	1,639.5
Rhode Island	-------	-------	-------	1.8	17.4	47.3	51.6	------	-------	118.2
South Carolina	40.5	1,289.6	115.6	8.9	3.0	89.0	81.4	.2	10.9	1,639.2
South Dakota	495.1	18.2	2,101.5	-------	-------	-------	1.2	------	2.1	2,618.1
Tennessee	149.4	-------	117.0	52.2	416.2	27.7	211.2	------	1.6	975.4
Texas	795.0	83.9	2,963.0	527.0	622.4	120.6	509.2	29.2	8.0	5,658.2
Utah	94.3	41.7	472.1	9.3	.7	9.9	91.6	------	1.7	721.1
Vermont	-------	-------	99.8	3.5	30.1	-------	21.2	------	5.8	160.5
Virginia	58.9	212.5	121.6	108.6	303.5	10.6	364.7	------	2.4	1,182.8
Washington	125.8	-------	321.1	-------	-------	-------	273.2	------	2.1	722.2
West Virginia	164.8	5.6	18.2	4.9	124.5	21.3	123.1	11.4	.5	474.2
Wisconsin	206.0	115.5	920.8	2.7	13.8	-------	488.5	------	1.4	1,748.6
Wyoming	405.6	485.4	418.0	-------	-------	22.1	14.8	------	4.1	1,350.2
Hawaii	-------	-------	-------	-------	6.5	-------	-------	------	-------	6.5
Total	10,798.9	5,721.7	25,547.5	1,309.9	3,680.0	1,818.9	14,391.2	773.8	167.6	64,209.7

TABLE 14.—*Mileage of Federal-aid roads under construction on June 30, 1927, by types of construction*

State	Graded and drained	Sand-clay	Gravel	Water-bound mac-adam	Bitu-minous mac-adam	Bitu-minous con-crete	Port-land-cement con-crete	Brick	Bridges	Total
Alabama	102.1	87.6	87.0		21.1		1.7		0.5	299.9
Arizona		11.6	14.1				.4		1.7	27.8
Arkansas	44.1		120.7		17.6		1.2		1.1	184.7
California	30.4		21.2	9.8		6.4	23.8		.8	92.4
Colorado	33.1	11.2	57.7				38.6		1.0	141.5
Connecticut				8.2			38.4		3.5	50.1
Delaware							27.6		.3	27.9
Florida	56.5			16.2	23.4	13.9	11.5		4.3	125.8
Georgia	69.7	19.8	9.7	6.8	7.5		23.5		.6	137.5
Idaho	8.8		63.4			7.8	3.4		.6	83.9
Illinois	44.4						292.4	6.2	.4	343.4
Indiana	10.7						345.6	11.0	.6	367.9
Iowa	160.7		67.1				228.5		.3	456.6
Kansas	337.3	31.3	28.1		27.8		104.0	22.5	4.1	555.1
Kentucky	256.8		30.9		66.3		39.0		.4	393.4
Louisiana	22.9		43.4			23.7	12.9		2.2	105.1
Maine			36.1		1.9		30.3		1.2	69.6
Maryland					11.5		18.4			29.9
Massachusetts			0.5		34.1	9.8	17.9		.3	62.6
Michigan	43.9		42.7				199.5		1.9	288.0
Minnesota	354.4		6.2				9.4		.1	370.0
Mississippi	144.8		120.1				33.4	.5	2.2	301.1
Missouri	56.1		3.4				74.4			134.0
Montana	4.3		114.0	.8					.5	119.6
Nebraska	224.1	559.8	101.1			.2	14.9		.4	900.6
Nevada			95.6							95.6
New Hampshire				11.7	8.9		4.2		2.2	27.1
New Jersey	2.8						79.7			82.5
New Mexico	70.7		98.2				8.6		1.0	178.5
New York	52.0		28.0		13.3		445.5		.4	539.3
North Carolina							58.1		.6	58.7
North Dakota	571.2	2.5	28.5						.6	602.8
Ohio	44.0			28.4	74.6		131.8	18.1	1.8	298.6
Oklahoma	106.2						27.2		1.3	134.8
Oregon	57.0		4.8						.3	62.2
Pennsylvania	44.1				22.9		150.7		.1	217.9
Rhode Island					15.1		5.3			20.4
South Carolina	8.8	105.8	18.5			1.0	25.3		5.7	165.0
South Dakota	379.9		112.3				15.7		.5	508.4
Tennessee	65.3		6.8		12.6	5.6	27.3		1.4	119.0
Texas	133.3		50.7	5.9	102.9		48.8		1.7	343.3
Utah			80.5						.8	81.3
Vermont			1.1		15.2		17.2		.4	33.9
Virginia					11.5		82.8		1.2	95.5
Washington	27.7		27.5						1.9	57.1
West Virginia	112.5		5.4		25.1	19.3	19.9		1.2	183.4
Wisconsin	8.4	8.2	192.9				145.3		1.7	356.4
Wyoming	122.4		15.3				5.2		.4	143.2
Hawaii					13.8		15.9			29.7
Total	3,811.4	837.8	1,733.5	87.8	527.1	87.7	2,905.2	58.3	54.2	10,103.0

TABLE 15.—*Mileage of Federal-aid roads approved for construction on June 30, 1927*

State	Graded and drained	Sand-clay	Gravel	Water-bound mac-adam	Bitu-minous mac-adam	Bitu-minous con-crete	Port-land-cement con-crete	Brick	Bridges	Total
Alabama		1.8							0.1	1.9
Arizona		19.0							.1	19.1
Arkansas	15.6						1.4		2.4	19.4
California						4.5				4.5
Colorado			2.9							2.9
Connecticut							12.7		.3	13.0
Delaware			5.7		5.3					11.0
Florida					23.8				.4	24.2
Georgia							.3			.3
Idaho	2.2		6.7						.4	9.3
Illinois	37.5						149.2		.2	187.0
Indiana							68.8			68.8
Iowa	3.4		1.2				39.5			44.1
Kansas	77.4	51.2	27.4				10.5		.5	167.0
Kentucky	38.6				4.0				.2	42.8
Louisiana									.9	.9
Maine			5.6							5.6
Maryland					38.9		27.7			66.6
Massachusetts							2.3			2.3
Michigan			3.2				22.9		.2	26.3
Minnesota	19.4									19.4
Mississippi	39.0		24.2				2.0			65.2
Missouri	28.7						39.5		.2	68.4
Montana	28.5		255.5	20.6					1.3	305.9
Nebraska	40.9	119.2	2.5				2.8		1.2	166.6
New Hampshire				.9	6.1		1.8			8.8
New Jersey							5.9			5.9
New York			10.9		13.2		131.5			155.6
North Carolina							36.8			36.8
North Dakota	306.3		14.4						.1	320.8
Ohio	3.1			2.3			15.0	0.2	.2	20.8
Oklahoma	65.3						6.1		.1	71.5
Oregon	9.9									9.9
Pennsylvania	3.4						59.9		.9	64.2
Rhode Island					3.5		5.8			9.3
South Carolina	8.0					11.5	3.4			22.9
South Dakota	115.6		15.7						.2	131.5
Texas	34.9		7.2	9.1	.9		2.5			54.7
Utah			37.6						.1	37.6
Vermont			5.7		4.3		17.3		.2	27.4
Virginia			.2				18.7		.1	19.0
Washington	6.5						3.6			10.1
West Virginia	5.7		5.9				15.3			26.9
Wisconsin			9.7				9.7			19.4
Total	889.9	191.2	442.2	32.9	100.0	16.0	712.9	.2	10.3	2,395.6

TABLE 16.—*Mileage of stage construction completed during fiscal year 1927, by types of construction*

State	Graded and drained	Gravel	Water-bound macadam	Bituminous macadam	Bituminous concrete	Portland-cement concrete	Total
Alabama						4.6	4.6
Arizona		0.4					.4
California						17.3	17.3
Georgia			8.8	9.8	10.0	34.7	63.3
Idaho				4.9	8.0	.2	13.1
Illinois						2.0	2.0
Indiana			11.6				11.6
Iowa		54.4				19.8	74.3
Kansas						.1	.1
Kentucky						14.6	14.6
Michigan						25.7	25.7
Minnesota		81.4				33.2	114.6
Missouri		2.7				26.9	29.6
Montana		62.6					62.6
Nebraska	21.0	206.1			.1	11.5	238.6
Nevada		11.0					11.0
North Carolina					8.6	28.9	37.5
North Dakota		362.8				.1	362.9
Ohio		6.7				6.7	13.4
Oklahoma						10.1	10.1
South Carolina					12.0	3.4	15.4
South Dakota		154.4					154.4
Tennessee						19.1	19.1
Texas		6.5		10.9		22.5	39.8
Wisconsin		7.8					7.8
Wyoming		32.8					32.8
Total	21.0	989.6	20.3	25.6	38.7	281.4	1,376.6

TABLE 17.—*Mileage of projects on which stage construction was in progress on June 30, 1927*

State	Graded and drained	Sand-clay	Gravel	Water-bound mac-adam	Bituminous mac-adam	Bituminous con-crete	Portland-cement concrete	Brick	Total
Alabama							1.9		1.9
Colorado						9.1			9.1
Delaware							1.8		1.8
Georgia							40.0		40.0
Idaho						15.5			15.5
Iowa			85.1				81.3		166.4
Kansas		3.5					4.1		7.6
Kentucky					4.1				4.1
Minnesota			3.9				111.8		115.7
Mississippi							14.8		14.8
Missouri	9.9		3.0				16.4		29.3
Montana			1.6	4.1					5.7
Nebraska		307.3	3.5				33.4		344.1
North Dakota			118.5						118.5
Ohio							3.4	.8	4.2
Oklahoma							12.2		12.2
Oregon			32.6						32.6
South Carolina							13.0		13.0
South Dakota			38.2						38.2
Tennessee							27.5		27.5
Texas				14.2	103.0	4.4	18.2		139.7
West Virginia					4.0				4.0
Wisconsin			4.5				30.7		35.2
Wyoming			32.2						32.2
Total	9.9	310.8	323.1	18.3	111.1	29.0	410.3	.8	1,213.3

TABLE 18.—*Status of Federal-aid highway system, June 30, 1927*

State	Mileage of Federal-aid system approved to June 30, 1927	Federal-aid mileage completed during fiscal year	Federal-aid mileage completed to June 30, 1927
Alabama	3,884.0	78.3	1,494.0
Arizona	1,498.0	68.6	835.7
Arkansas	5,021.1	168.9	1,587.4
California	4,771.5	195.6	1,365.3
Colorado	3,332.0	166.6	963.6
Connecticut	835.4	24.0	151.1
Delaware	415.8	40.2	164.5
Florida	1,926.0	65.9	315.6
Georgia	5,558.4	394.3	2,369.8
Idaho	2,770.0	177.0	950.7
Illinois	6,616.8	76.3	1,543.4
Indiana	4,701.5	154.3	841.5
Iowa	7,212.0	415.6	2,592.6
Kansas	7,892.0	361.1	1,624.7
Kentucky	3,702.5	110.6	898.0
Louisiana	2,722.8	144.7	1,214.5
Maine	1,393.5	59.2	362.8
Maryland	1,503.7	58.5	481.8
Massachusetts	1,308.0	55.0	440.7
Michigan	5,235.0	165.9	1,161.5
Minnesota	6,849.6	394.3	3,643.5
Mississippi	3,604.0	217.8	1,376.7
Missouri	7,530.0	281.9	2,077.6
Montana	4,665.0	90.3	1,161.8
Nebraska	5,569.1	629.9	2,651.1
Nevada	1,398.0	230.6	940.7
New Hampshire	980.9	23.9	268.5
New Jersey	1,198.3	37.2	345.1
New Mexico	3,298.0	69.8	1,560.3
New York	5,018.0	248.0	1,479.8
North Carolina	3,860.8	145.9	1,489.0
North Dakota	7,194.0	576.0	2,851.7
Ohio	5,899.3	128.1	1,550.7
Oklahoma	5,528.0	183.0	1,384.5
Oregon	2,814.0	93.6	1,055.2
Pennsylvania	4,602.1	204.3	1,639.5
Rhode Island	356.9	23.9	118.2
South Carolina	3,230.0	102.3	1,639.2
South Dakota	5,747.0	272.3	2,618.1
Tennessee	3,252.8	140.1	975.4
Texas	11,404.7	602.4	5,658.2
Utah	1,677.3	98.5	721.1
Vermont	1,043.0	25.3	160.5
Virginia	3,233.0	132.7	1,182.8
Washington	2,927.5	53.6	722.2
West Virginia	2,000.6	59.7	474.2
Wisconsin	5,493.3	129.5	1,748.6
Wyoming	3,097.0	125.1	1,350.2
Hawaii	----------	6.5	6.5
Total	185,772.2	8,306.9	64,209.7

TABLE 19.—*Federal-aid apportionments to States, expenditures, and balances, as of June 30, 1927*

States	Apportionments	Expenditures	Balances unexpended
Alabama	$15,896,675.00	$11,125,402.51	$4,771,272.49
Arizona	10,674,243.00	6,980,384.61	3,693,858.39
Arkansas	12,883,700.00	10,089,256.29	2,794,443.71
California	24,556,252.00	19,099,020.27	5,457,231.73
Colorado	13,702,332.00	9,418,994.91	4,283,337.09
Connecticut	4,806,366.00	2,966,704.26	1,839,661.74
Delaware	2,839,683.00	2,367,415.41	472,267.59
Florida	8,984,405.00	6,283,048.37	2,701,356.63
Georgia	20,411,162.00	17,975,400.90	2,435,761.10
Idaho	9,494,820.00	7,924,889.57	1,569,930.43
Illinois	32,986,627.00	24,974,208.95	8,012,418.05
Indiana	20,131,127.00	15,560,764.82	4,570,362.18
Iowa	21,530,562.00	16,647,810.85	4,882,751.15
Kansas	21,532,943.00	17,402,790.48	4,130,152.52
Kentucky	14,630,756.00	11,330,190.92	3,300,565.08
Louisiana	10,285,716.00	8,158,528.87	2,127,187.13
Maine	7,145,622.00	5,385,074.63	1,760,547.37
Maryland	6,560,176.00	5,796,203.88	763,972.12
Massachusetts	11,197,826.00	7,593,592.97	3,604,233.03
Michigan	22,557,056.00	17,355,453.04	5,201,602.96
Minnesota	21,712,521.00	19,523,215.55	2,189,305.45
Mississippi	13,435,897.00	10,709,299.33	2,726,597.67
Missouri	25,191,611.00	20,896,412.65	4,295,198.35
Montana	14,976,384.00	7,777,595.32	7,198,788.68
Nebraska	16,220,373.00	11,234,189.87	4,986,183.13
Nevada	9,743,725.00	8,577,014.05	1,166,710.95
New Hampshire	3,535,117.00	2,906,382.08	628,734.92
New Jersey	9,402,031.00	7,495,364.48	1,906,666.52
New Mexico	12,159,149.00	8,985,251.20	3,173,897.80
New York	37,680,412.00	25,044,440.67	12,635,971.33
North Carolina	17,430,562.00	15,316,377.52	2,114,184.48
North Dakota	11,943,610.00	9,330,969.92	2,612,640.08
Ohio	28,494,005.00	21,753,059.40	6,740,945.60
Oklahoma	17,811,678.00	14,999,664.74	2,812,013.26
Oregon	12,061,549.00	10,749,871.72	1,311,677.28
Pennsylvania	34,674,516.00	28,608,232.22	6,066,283.78
Rhode Island	3,033,194.00	2,025,415.30	1,007,778.70
South Carolina	10,856,512.00	9,434,757.33	1,421,754.67
South Dakota	12,386,854.00	10,444,848.97	1,942,005.03
Tennessee	16,895,357.00	13,870,889.36	3,024,467.64
Texas	45,103,703.00	36,121,317.50	8,982,385.50
Utah	8,665,685.00	6,858,844.71	1,806,840.29
Vermont	3,634,132.00	2,786,814.20	847,317.80
Virginia	14,944,228.00	13,270,002.02	1,674,225.98
Washington	11,277,308.00	9,484,672.13	1,792,635.87
West Virginia	8,146,147.00	6,113,846.44	2,032,300.56
Wisconsin	19,309,270.00	13,663,937.53	5,645,332.47
Wyoming	9,500,643.00	7,932,108.33	1,568,534.67
Hawaii	1,465,778.00	321,617.71	1,144,160.29
Total	744,500,000.00	580,671,548.76	163,828,451.24

NATIONAL-FOREST ROAD CONSTRUCTION

The systems of forest roads in the several States have been increased by new designations during the year and now include 13,842 miles, of which 11,522 miles are in the 11 States of the Mountain and Pacific groups and the Territory of Alaska. As previously reported, all appropriations for forest-road construction are being expended upon these systems.

As shown by Table 20, the mileage of class 1 highways, upon which it is planned to expend until they are completed approximately 70 per cent of each annual appropriation is now 1,079 miles, of which 833 miles are in the Western States. These are the more important highways which are necessary sections or extensions of the Federal-aid system wholly within the forest areas. The class 2 highways, which also extend the Federal-aid system, are increased by the recent additions to a total mileage of 7,060, of which 6,687 miles are in the West, and the class 3 highways—those that serve principally the communities within the forests—now aggregate 5,703 miles, of which 4,002 miles are in the 11 Western States and Alaska.

TABLE 20.—*Classified mileage of forest highway system in several States*

State	Mileage of forest highway system			
	Class 1	Class 2	Class 3	Total
Western:	*Miles*	*Miles*	*Miles*	*Miles*
Alaska			373.6	373.6
Arizona	174.0	499.0	248.0	921.0
California	322.9	995.6	757.0	2,075.5
Colorado		1,243.0	527.0	1,770.0
Idaho		738.1	351.1	1,089.2
Montana	145.0	660.0	377.0	1,182.0
Nevada		366.0	94.0	460.0
New Mexico [1]	115.0	211.0	199.0	525.0
Oregon [1]	58.0	872.4	445.0	1,375.4
Utah		457.9	299.0	756.9
Washington	18.4	263.7	181.9	464.0
Wyoming		380.0	149.0	529.0
Total	833.3	6,686.7	4,001.6	11,521.6
Eastern:				
Alabama			46.5	46.5
Arkansas	131.0	51.0	20.0	202.0
Florida	3.0	13.0	106.0	122.0
Georgia	18.0		115.0	133.0
Kentucky		6.0	6.0	12.0
Maine			11.0	11.0
Michigan			55.0	55.0
Minnesota		38.5	142.0	180.5
Nebraska			25.0	25.0
New Hampshire	18.3	15.5	62.5	96.3
New Jersey		3.0	5.5	8.5
North Carolina	49.0		199.0	248.0
Oklahoma			33.0	33.0
Pennsylvania	24.5		166.0	190.5
Porto Rico				
South Carolina		6.0	40.0	46.0
South Dakota	2.0	153.0	59.0	214.0
Tennessee		55.0	188.0	243.0
Virginia		28.0	273.0	301.0
West Virginia		4.0	149.0	153.0
Total	245.8	373.0	1,701.5	2,320.3
Grand total	1,079.1	7,059.7	5,703.1	13,841.9

[1] System designated by Bureau of Public Roads not yet approved by the Secretary of Agriculture.

As shown by Table 21, 452.85 miles of forest highways of all classes were completed during the year. Of this total, 378.9 miles were in the 11 Western States and Alaska and the remaining 73.95 miles were in the forest areas of 7 Eastern States.

The total mileage completed to date, including the results of the last year's work, is 3,498.45 miles, of which 3,182.94 miles is in the West and 315.51 miles in the East.

Outstanding in the work of the year was the completion of the Durango-Silverton Road in Colorado. This famous project in the San Juan National Forest has been under construction since 1918. Lying on the west slope of the Continental Divide, it serves as the north entrance to the San Juan Basin and one of the best approaches to Mesa Verde National Park. On account of the altitude, it is closed by snow for all but three and a half months in the summer. The section built by the Government is 33.14 miles in length, and with the widening which was effected after completion of the original construction the cost has been $560,550.

TABLE 21.—*Mileage of completed forest highway projects by States*

State	Mileage of forest highway projects completed	
	During 1927	Total to June 30, 1927
Western:	*Miles*	*Miles*
Alaska	5.21	151.62
Arizona	20.47	237.12
California	49.60	252.16
Colorado	54.56	265.96
Idaho	55.96	439.58
Montana	40.26	343.61
Nevada	9.69	103.91
New Mexico	0.07	164.17
Oregon	51.73	516.61
Utah	26.01	285.00
Washington	4.24	188.30
Wyoming	61.10	234.90
Total	378.90	3,182.94
Eastern:		
Alabama	5.00	5.00
Arkansas		56.76
Florida		64.24
Georgia	9.96	18.59
Kentucky		
Maine		
Michigan		
Minnesota		34.57
Nebraska		
New Hampshire	1.35	3.59
New Jersey		
North Carolina	19.89	36.27
Oklahoma		
Pennsylvania		
Porto Rico		
South Carolina		5.27
South Dakota	6.75	41.51
Tennessee	25.60	37.83
Virginia	5.40	11.88
West Virginia		
Total	73.95	315.51
Grand total	452.85	3,498.45

Other important highways completed during the year include the Saxman-Mountain Point section of the Tongass Highway in Alaska; the Cherry Creek Hill section of the Salt River-Pleasant Valley Highway in Arizona; the Camp Rock section of the Independence Pass Highway in Colorado; the Crooked Fork section of the Lewis and Clark Highway, the Peasley

Creek section of the Elk City Highway, and sections 1, 2, and 3 of the Salmon-Montana Line Highway in Idaho; the Garry section of the Columbia Falls-Glacier Park Highway in Montana; the Schofield section of the Scottsburg-Reedsport project and the Fall Creek section of the Alsea River Highway in Oregon; and the San Francisco River bridge on the Datil-Reserve-Dry Creek Highway in New Mexico.

A number of previously graded projects were surfaced during the year. Among these the most important were the Snowflake-Pinetop project in Arizona; the Warm River-Yellowstone project in Idaho; the Austin-Unity section of the Prairie City to Unity project and the Cloud Cap Inn project in Oregon; and the Shuksan-Austin Pass section of the Mount Baker Highway in Washington.

By agreement with the Governor of Alaska and the Forest Service, the bureau has undertaken a survey of the highway needs of those sections of Alaska located within and adjacent to the national forests. One of the principal purposes of the survey is to ascertain what may and should be done by highway construction to develop the mineral deposits, forest resources, water-power, and other natural possibilities of southeastern Alaska. This region at present is inaccessible even to prospectors, and it appears that the construction of a few low-type roads will do much to facilitate a proper development.

It will not be possible in all cases to predict that such roads as may now be built will continue in the future to serve adequately the needs of the developed territory, but every effort will be made to provide for future as well as immediate needs. So far as possible, the roads will be so located that they will continue to meet the highway requirements of the section in the future if surfaced and otherwise further improved in accordance with traffic demands. In some cases the roads at first constructed may prove to require relocation after the pioneer period, but it is hoped by a very thorough study of the region to anticipate the direction of development and so avoid the necessity of subsequent relocation as far as possible.

In order more effectively to cooperate with the Territorial authorities in the survey and in the construction of the roads, the bureau has established a district office at Juneau, and the district engineer has been authorized to undertake the survey in conjunction with representatives of the Territory. It is expected that the roads found to be needed will be constructed with forest-highway funds.

Since entering into agreement with the National Park Service of the Interior Department to assist that service in the survey and construction of roads in the national parks there have been completed under the bureau's supervision approximately 74 miles of national-park roads and at the close of the year construction was under way on 103 miles additional. Besides this work of construction, the bureau has also made surveys of an extensive mileage and surveys of 233 miles are at present actively in progress.

The longest sections thus far completed are in Crater Lake, Sequoia, and Yosemite National Parks. Others have been completed in Glacier, Mount Rainier, Grand Canyon, Lassen Volcanic, General Grant, and Rocky Mountain National Parks.

The work at present under construction is in the same parks, with the exception of General Grant, and in addition there are approximately 7 miles in Hawaii.

One of the most interesting of the national-park projects is the work on the Transmountain Highway in Glacier National Park. Here is a road in which practically every conceivable obstacle has been met and overcome. The 16-foot roadway is being literally hewn out of the solid rock of the Garden Wall in order to reach and cross the Continental Divide. The west side section, which has been under construction for some time, is 15.7 miles long, and the cost of grading and surfacing with crushed stone will probably be about a million dollars. At the close of the fiscal year work on this section was about two-thirds completed.

In Mount Rainier National Park work is in progress on the Nisqually Road. Three bridges have been completed on this road at a cost of more than $66,000, and the Longview section, 11.77 miles long, is nearly completed. The improvement on this section consists of grading and crushed-rock surfacing to a width of 18 feet, at a cost approaching $280,000. The Round Pass section of the West Side Highway in this same park is also under construction, the improvement consisting of 10 miles of grading and 16-foot crushed-rock surfacing. The indicated cost of this road is over $400,000, but it was only about one-eighth completed at the close of this fiscal year.

The El Portal-Floor of the Valley Highway in Yosemite is another million-dollar project. The improvement here

is of a higher type than in the cases previously mentioned on account of the heavier traffic. Two sections of the road are under construction, the first involving the laying of an 18-foot bituminous-concrete surface on 13.63 miles, and the second consisting of the grading of 13.79 miles and subsequent surfacing with bituminous macadam.

At the Grand Canyon work is under way on both the north and south rims. In Rocky Mountain National Park the grading of the 7-mile Bear Lake project is almost half completed, and in far-away Hawaii the Chain of Craters project, involving nearly 7 miles of grading and gravel surfacing, is well under way.

These are merely a few of the important roads now under construction in the parks. When they are completed they are likely to be rated among the most interesting tourist roads in America, and the Zion Canyon Road in Utah, shortly to be started, is destined in many ways to surpass them in interest.

RESEARCH

The research activities of the bureau are carried on principally by four divisions, namely, the division of tests, which is responsible for physical researches in the highway field; the division of economics and highway transportation, which has charge of traffic surveys and other economic studies of highways and their use; the division of control, which makes studies of the efficiency of highway construction and maintenance operations; and the division of agricultural engineering, which conducts numerous researches in connection with the application of engineering principles to agriculture.

The line of demarcation between the respective fields of these research divisions can not be sharply drawn. Even the work of the division of agricultural engineering, between which and the other divisions there is less in common than the others have between them, deals with questions which are also under investigation from other points of view by the highway research division. For example, the agricultural engineering division has under way studies of the permeability of soils, the run-off of rainfall from the surface of the land, the flow of water in pipes and flumes of various materials, the effect of alkali and soil acids on concrete, the drainage of soils, the economy of transporation by motor vehicle and other means, all of which are of interest in somewhat different application to those who are studying problems of the highways, and, as previously stated, the proper work of the three highway divisions even more frequently runs along parallel lines.

In order to prevent undesirable duplication of effort and to facilitate cooperation between these four divisions and also to bring to bear upon their work and its results the constructive criticism of those in other branches of the organization whose duties have to do with the application and dissemination of the results of research, there has been created during the past year a research committee. Its membership is composed of the heads of the four research divisions, the chief of the division of design, and the two assistants to the chief of bureau. This committee considers all research projects before they are undertaken, with a view to ascertaining whether they are of sufficient importance to warrant the expenditure of effort and funds required, reviews all results obtained from the work undertaken, and endeavors to promote harmonious and mutually helpful cooperation between the several divisions. Its recommendations are made to the chief of bureau, who takes such action as seems desirable in the circumstances.

The fundamental researches into the magnitude and effects of motor-truck impact and the characteristics of soils as highway subgrades have been carried on with satisfactory results throughout the year and will be continued.

IMPACT INVESTIGATIONS

In the impact investigation attention has been directed during the year mainly to the study of the effects of road roughness and of the characteristics of the springs and tires of vehicles. This phase of the work has been conducted in cooperation with the Rubber Association of America and the Society of Automotive Engineers, and information has been obtained which will be useful to manufacturers of rubber tires and vehicles in the development of refinements of vehicular design which will tend to reduce the impact applied to the road and correspondingly reduce the shocks reacting against the vehicles and their passengers.

As the year drew to a close arrangements were being made to test the effects of various types of cushion wheels now offered by manufacturers, and also to ascertain with greater certainty the relative impact resulting from corresponding drops of a wheel on different types of highway surfacing and pavement. Interest in this latter

connection lies especially in a comparison of concrete pavements and pavements constructed with an asphaltic top on a concrete base. Information of this character is needed to permit these competing types of pavements to be considered upon a basis of comparable strength.

SUBGRADE STUDIES

In the subgrade-soil investigation very promising progress has been made in the development of tests by which the properties of the soils which affect their value as subgrade materials may be measured, and plans have been perfected for extensive soil surveys to be made with the assistance of the State highway departments and the Bureau of Chemistry and Soils.

The information already collected by the Bureau of Chemistry and Soils will be used as the starting point in these surveys, and will be extremely valuable. The principal object of the new surveys will be to ascertain the value of the soils—previously classified with respect to their agricultural possibilities—as road subgrades. This will be accomplished by accumulating evidence of the behavior and condition of pavements laid upon them, as well as by tests of the soils themselves by the methods now being perfected.

The purposes and aims of the bureau in making these subgrade studies may be briefly stated as follows:

1. To determine the practicability of varying the type or design of road surface to suit subgrade conditions.

2. To ascertain the efficiency of various methods of drainage and subgrade treatment and types of subbase.

3. To determine the relative economy of subgrade correction (treatment, drainage, or subbase) and change in pavement design (type, thickness, or other features) as compensation for varying subgrade conditions.

As indicating the large savings that may be possible as the result of the adjustment of the surfacing material or pavement to the particular characteristics of various subgrades when these characteristics and their effects are understood the following instances are of interest.

On the Maryland highway between Beacon Hill and Elkton about 30 per cent of one section of the concrete pavement is badly broken while an adjoining section is intact. The difference in conditions has been definitely traced to the character of the subgrade under the two sections. If these differences had been fully understood and compensated for in the design of the pavement on the two sections a considerable loss could have been avoided, and similar losses could be prevented in other sections.

East of Cleveland, Ohio, brick surfaces laid on 4-inch concrete base have given satisfactory service for years, while a similar surface laid on a 6-inch base south of the city has proved inadequate. The difference is again a question of subgrade support, and there is involved in the proper answer to the question a sum amounting to several thousand dollars a mile.

Finally, as indicating the possibilities of subgrade treatment reference may be made to a section of gravelly soil road treated with bituminous materials in New Hampshire, which has accommodated traffic through two winters, in contrast with other untreated sections of the same road into which the wheels of vehicles have sunk to their hubs. The additional support afforded by the treated soil is plainly indicated, and the difference is such as to warrant a material reduction in the thickness of surfacing material or pavement if such were required for the accommodation of traffic.

LIGHT OIL TREATMENT OF CRUSHED ROCK

Of immediate interest to the Western States is an investigation which has been carried on jointly during the past year by the bureau and the California State Highway Commission, the purpose of which is to estimate the possibilities of developing a type of surfacing for roads of intermediate traffic density by the treatment of crushed-rock and gravel roads with light "fuel oils." If the treatments which are now being applied experimentally on many miles of highway in Oregon and California and other Western States should in the long run prove as satisfactory as the experience to date indicates, these methods will doubtless provide a key to the serious problems of county and local road improvement in many other parts of the country.

The use of fine crushed-rock and gravel surfaces on lightly traveled western roads has been mentioned in previous annual reports. Many miles of such surfaces have been laid on roads which obviously required some improvement beyond grading and drainage, and it has been found that they are subject to two serious objections. In the first place, they are very dusty, and in the second, they are so rapidly worn down by the wheels of vehicles that as much as an inch or

more of metal may be lost in a single year.

In the effort to eliminate the dust nuisance and reduce wear, methods of treating such surfaces with light fuel oils have been developed which not only accomplish the results initially sought, but which, it now seems, will produce road surfaces of exceptional smoothness and high service value.

With the cooperation of the California commission examples of this type of improvement have been carefully studied during the past year and a report has been prepared which will shortly be placed in the hands of highway officials throughout the country in order to draw attention to the possibilities of the treated roads and to disseminate a knowledge of certain essential principles upon which their successful construction appears to depend.

CONCRETE ARCH BRIDGE TEST

During the year there was presented to the bureau an unusual opportunity to test to destruction a large concrete arch bridge of modern construction in North Carolina. The design of concrete arches has been developed largely on the basis of theoretical analysis and tests of model bridges, and while the methods devised have been generally satisfactory there has been no opportunity to verify them by comparison of computed stresses under maximum loads with the actual stresses developed under such loads.

The bridge upon which it has now become possible to make such a comparison was built in 1922 over the Yadkin River in North Carolina as a Federal-aid project. All details of the design are therefore well known to the bureau. A dam now under construction downstream will soon submerge the bridge and it has become necessary to replace it; consequently it may be tested to destruction, and this will be done by the bureau in cooperation with the North Carolina State Highway Commission and with the advice of national engineering and scientific associations and other interested agencies.

The bridge consists of three open-spandrel arch spans of about 150 feet each and 14 T-beam or deck-girder spans of approximately 40 feet each, making an overall length of 1,069 feet.

By the end of the year an advisory committee representing the agencies mentioned had been formed, and plans had been worked out in detail for the tests which will be begun as soon as it becomes possible to divert traffic. Large water tanks have been made ready for the application of load, instruments and procedure have been decided upon, preliminary temperature stress measurements have been made, and it is expected that the tests under load will be begun in October.

This is an exceptionally important test, the results of which will be of great value to the engineering profession as a whole, and it will be watched and studied with corresponding interest.

TRAFFIC SURVEYS

Traffic surveys similar to those conducted previously in cooperation with the authorities of Maine, Connecticut, Pennsylvania, Ohio, and Cook County, Ill., have been carried on during the past year in New Hampshire and Vermont in cooperation with the respective State highway departments. Reports which will serve as the basis of the planning of future highway improvements have been prepared and will shortly be printed.

The value of these surveys as a means of assuring the proper adjustment of expenditure and highway design to actual present and estimated future traffic requirements can scarcely be overrated.

The traffic-flow maps and other evidence of the character, weight, and usage of vehicles developed from the surveys present to those charged with the administration of the work of highway improvement a picture of the relative importance of the various roads which permits of the preparation of sound budgets and adequate highway designs and also makes possible the scheduling of improvement of each section of highway with respect to others in the order of their true traffic importance.

CONSTRUCTION-EFFICIENCY STUDIES

Continuing the studies of the efficiency of road-construction processes reported last year, attention has been directed this year to the analysis of power-shovel operation. The cost of grading is perhaps the largest single item in the highway bill of the country, and a great deal of the grading is done with steam and gasoline shovels.

The operation of these important tools involves a number of repetitive operations. The dipper must be loaded, swung, and spotted over the hauling unit, the load dumped, and the dipper returned for another load. From time to time the shovel must be moved for-

ward or maneuvered to keep it within digging reach of the material in which it is working. The hauling equipment—wagons or trucks—must be brought into position by the side of the shovel and loaded; they must then move to dump, deposit their load, and return to the shovel for another, turning and maneuvering in order to get within convenient reach of the shovel arm. As these operations are repeated over and over again throughout the day, a few seconds or even fractions of seconds regularly lost in any part of the operation, or any failure properly to adjust the hauling equipment to the capacity of the shovel, inevitably results in a loss in productivity which soon mounts to large proportions.

As in the other efficiency studies previously conducted, the various phases of power-shovel operation have been analyzed with a stop watch and the time required for efficient operation has been determined. Testing by these standards the operation of shovels by contractors under various conditions, it is found to be possible, by good management, to make material improvements in efficiency in most cases.

The facts developed in these studies will shortly be published in the bureau's periodical Public Roads, and the information will also be disseminated to contractors and engineers by papers in the engineering and contracting publications, by addresses before associations of contractors and engineers, and in other ways.

The efficiency studies involving, as they do, an intimate study of the details of road-construction processes afford an excellent opportunity for the training of young engineers, and they are being so utilized. Every spring a number of junior students in the engineering schools are selected for employment during the summer as assistants in the studies. Working under careful direction, these young men receive a practical knowledge of road construction which constitutes a very desirable supplement to their theoretical training. Upon graduation a year later those that have manifested the highest proficiency and fitness are permanently employed and their training is continued, first in connection with the efficiency studies and later in other branches of the work of the bureau, after which they are assigned to regular duty in the work for which they have shown the greatest fitness. In this way a corps of thoroughly trained young engineers is being developed from which to fill vacancies as they occur in the higher positions of the bureau and the State highway departments.

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